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FINAL REVISED SITE INSPECTION OF THE FORMER SMALL ARMS FIRING RANGES NAS OCEANA VIRGINIA BEACH VA

1/1/2012

CH2M HILL

Final

Revised Site Inspection of the Former Small Arms Firing Ranges

Naval Air Station Oceana
Fleet Combat Training Center - Dam Neck Annex
Naval Auxiliary Landing Field – Fentress
Virginia Beach, Virginia

Naval Facilities Engineering Command

Prepared for

Department of the Navy

Naval Facilities Engineering Command Mid-Atlantic

Contract No. N62470-08-D-1000
CTO-WE03

January 2012

Prepared by

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Mid-Atlantic

Under the

Navy CLEAN 1000 Program
Contract N62470-08-D-1000

Prepared by

CH2MHILL

Virginia Beach, Virginia

Declaration

Site Name and Location

Pistol Range North
Naval Air Station (NAS) Oceana – Dam Neck Annex
Virginia Beach, Virginia

Statement of Basis and Purpose

This Statement of Basis and Purpose and stakeholder signatures documents the conclusion that no further action (NFA) is necessary to ensure protection of human health and the environment at the Pistol Range North at NAS Oceana – Dam Neck Annex in Virginia Beach, Virginia. This determination has been made in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. This decision is based on the Site Inspection report and information contained in the Administrative Record for the site. The Navy, in partnership with the Virginia Department of Environmental Quality, concurs with the NFA determination.

Rationale for No Further Action Determination

Based on the results of the Site Inspection, no potentially unacceptable human health or ecological risks and no CERCLA releases were identified at the Pistol Range North. Because there are no hazardous substances, pollutants, or contaminants remaining onsite above levels that prevent unlimited use and unrestricted exposure, no further action is necessary for the site to protect human health and the environment.

Authorizing Signatures

Mary Margaret Kutz — 1/26/11

Mary Margaret Kutz
Remedial Project Manager
Naval Facilities Engineering Command, Mid-Atlantic

Date

Stephen Mihalko — 2/2/11

Steve Mihalko
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Virginia Department of Environmental Quality

Date

Declaration

Site Name and Location

Pistol Range South
Naval Air Station (NAS) Oceana – Dam Neck Annex
Virginia Beach, Virginia

Statement of Basis and Purpose

This Statement of Basis and Purpose and stakeholder signatures documents the conclusion that no further action (NFA) is necessary to ensure protection of human health and the environment at the Pistol Range South at NAS Oceana – Dam Neck Annex in Virginia Beach, Virginia. This determination has been made in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. This decision is based on the Site Inspection report and information contained in the Administrative Record for the site. The Navy, in partnership with the Virginia Department of Environmental Quality, concurs with the NFA determination.

Rationale for No Further Action Determination

Based on the results of the Site Inspection, no potentially unacceptable human health or ecological risks and no CERCLA releases were identified at the Pistol Range South. Because there are no hazardous substances, pollutants, or contaminants remaining onsite above levels that prevent unlimited use and unrestricted exposure, no further action is necessary for the site to protect human health and the environment.

Authorizing Signatures

Mary Margaret Kutz ______________________ 1/26/11 ______________________
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Stephen Mihalko ______________________ 2/2/11 ______________________
Steve Mihalko — Date
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Virginia Department of Environmental Quality

Declaration

Site Name and Location

Rifle Range
Naval Air Station (NAS) Oceana – Dam Neck Annex
Virginia Beach, Virginia

Statement of Basis and Purpose

This Statement of Basis and Purpose and stakeholder signatures documents the conclusion that no further action (NFA) is necessary to ensure protection of human health and the environment at the Rifle Range at NAS Oceana – Dam Neck Annex in Virginia Beach, Virginia. This determination has been made in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986, and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan. This decision is based on the Site Inspection report and information contained in the Administrative Record for the site. The Navy, in partnership with the Virginia Department of Environmental Quality, concurs with the NFA determination.

Rationale for No Further Action Determination

Based on the results of the Site Inspection, no potentially unacceptable human health or ecological risks and no CERCLA releases were identified at the Rifle Range. Because there are no hazardous substances, pollutants, or contaminants remaining onsite above levels that prevent unlimited use and unrestricted exposure no further action is necessary for the site to protect human health and the environment.

Authorizing Signatures

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Acronyms and Abbreviations

µg/kg	microgram(s) per kilogram
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action - Navy
COPC	chemical of potential concern
CSM	conceptual site model
DoD	Department of Defense
Eco-SSL	Ecological Soil Screening Level
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ERS	Ecological Risk Screening
GPS	global positioning system
HHRA	Human Health Risk Assessment
HHRS	Human Health Risk Screening
HI	hazard index
HMW	high molecular weight
HQ	hazard quotient
HRSD	Hampton Roads Sanitation District
LMW	low molecular weight
LOAEL	Lowest Observed Adverse Effect Level
MATC	Maximum Acceptable Toxicant Concentration
MC	munitions constituents
mg/kg	milligram(s) per kilogram
mm	millimeter(s)
MRP	Munitions Response Program
NALF	Naval Auxiliary Landing Field
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NFA	no further action
NOAEL	No Observed Adverse Effect Level
PA	Preliminary Assessment
PAH	polycyclic aromatic hydrocarbon
PAL	project action limit
QA	quality assurance
QC	quality control
QSM	Quality Systems Manual
RSL	Regional Screening Level
SI	Site Inspection
UCL	Upper Confidence Limit
UFP-SAP	Uniform Federal Policy – Sampling and Analysis Plan
USEPA	United States Environmental Protection Agency

SECTION 1

Introduction

This report summarizes the Revised Site Inspection (SI) conducted by CH2M HILL under the Navy Munitions Response Program (MRP) at the former small arms firing ranges listed as follows:

Naval Air Station (NAS) Oceana

- Machine Gun Boresight Range

Fleet Combat Training Center – Dam Neck Annex

- Pistol Range North
- Pistol Range South
- Rifle Range
- Skeet and Trap Range

Naval Auxiliary Landing Field (NALF) Fentress

- Machine Gun Boresight Range

The Revised SI was conducted for the Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division, under the Comprehensive Long-term Environmental Action – Navy (CLEAN) CLEAN 1000 Program, Contract Task Order WE03, in accordance with the *Final Sampling and Analysis Plan for the SI at the Former Small Arms Firing Ranges (Field Sampling Plan and Quality Assurance Project Plan), NAS Oceana, Fleet Combat Training Center - Dam Neck Annex, Virginia Beach, Virginia* (CH2M HILL, 2010).

1.1 Project Objectives

The objective of the SI is to confirm or deny the potential source release of munitions constituents (MC) associated with small arms ammunition use and contaminants of concern within the defined boundaries of the six MRP sites, and if present, to determine whether these releases warrant further investigation or action. "The objectives of this SI are:

- To determine the presence or absence of a release of munitions constituents (MC) associated with small arms ammunition use within the defined boundaries of the six MRP sites
- If a release has occurred, to determine if further action is warranted to address the release(s)."

CH2M HILL performed the following field tasks to support these objectives:

- Marked sampling locations using a global positioning system (GPS)
- Completed a visual survey of each location, aided by a handheld all-metals detector, in order to bias sample locations toward areas having the presence of range-related surface debris, where there would be a higher likelihood of MC
- Collected discrete soil samples for laboratory analysis
- Collected discrete sediment samples from 20 locations at the Skeet and Trap Range for laboratory analysis
- Inspected and identified small arms projectiles and bullet jackets found at several sampling locations during routine collection activities

1.2 Report Organization

This report summarizes the results of the field efforts, provides an evaluation of the data, and provides recommendations for the path forward for the former small arms firing ranges. The report is organized into 11 sections:

- **Section 1—Introduction** provides an overview of the SI report and project objectives.
- **Section 2—Background** provides an overview of the base background and previous investigations.
- **Section 3—Field Investigation and Data Analysis** outlines the general investigation and data analysis methods used during the SI.
- **Section 4—Machine Gun Boresight Range (Oceana)** presents the site-specific background, field activities, analytical results, release assessment, risk evaluation, and summary and conclusions.
- **Section 5—Pistol Range North** presents the site-specific background, field activities, analytical results, release assessment, risk evaluation, and summary and conclusions.
- **Section 6—Pistol Range South** presents the site-specific background, field activities, analytical results, release assessment, risk evaluation, and summary and conclusions.
- **Section 7—Rifle Range** presents the site-specific background, field activities, analytical results, release assessment, risk evaluation, and summary and conclusions.
- **Section 8—Skeet and Trap Range** presents the site-specific background, field activities performed as part of the Revised SI, analytical results, release assessment, risk evaluation, and summary and conclusions
- **Section 9—Machine Gun Boresight Range (Fentress)** presents the site-specific background, field activities, analytical results, release assessment, risk evaluation, and summary and conclusions.
- **Section 10—Summary and Conclusions** presents overall conclusions and recommendations for all of the sites considered in this document.
- **Section 11—References** lists reports and other documents cited in this report.

SECTION 2

Background

2.1 NAS Oceana Location and History

NAS Oceana is located along the Atlantic Ocean, within the southeastern portion of the city of Virginia Beach, Virginia (**Figure 2-1**). The installation encompasses just over 5,300 acres, as well as approximately 3,600 acres in restrictive easements. In addition, NAS Oceana maintains control over several annex properties and outlying fields in the surrounding Virginia and North Carolina area. The mission of the facility is to support the Navy's Atlantic and Pacific fleet forces of strike-fighter aircraft and joint/interagency operations (Malcolm Pirnie, 2008).

2.1.1 NAS Oceana – Dam Neck Annex Location and History

Dam Neck Annex is located approximately 5 miles southeast of NAS Oceana in Virginia Beach and covers approximately 1,400 acres. The mission of this installation is to provide force-level engineering solutions, mission-critical and associated testing, and training technologies for maritime, joint, special warfare, and information operations domains (Malcolm Pirnie, 2008).

2.1.2 NAS Oceana – NALF Fentress Location and History

NALF Fentress is located in Chesapeake, Virginia, approximately 7 miles southwest of NAS Oceana. Established in 1940, the installation encompasses just over 2,500 acres and approximately 8,700 acres in restrictive easements. The facility is used primarily by squadrons stationed at NAS Oceana or Naval Station Norfolk Chambers Field for field carrier landing practice operations (Malcolm Pirnie, 2008).

2.2 Hydrology

NAS Oceana, Dam Neck Annex, and NALF Fentress lie within the boundaries of three drainage basins: the Chesapeake Bay watershed in the north, the Southern Watersheds Area in the south, and Owls Creek watershed in the east. The Southern Watersheds Area comprises the North Landing River, Northwest River, and Back Bay watersheds. Surface waters drain into the Chesapeake Bay via Great Neck, Wolfsnare, and London Bridge creeks; to the Southern Watersheds Area via West Neck Creek; and to Owls Creek watershed via Owls Creek and its tributaries (Geo-Marine, 2006).

Surface waters at NAS Oceana consist of several small ponds, wetlands, and an extensive network of artificial drainage channels and channeled stream courses. The station ponds are not naturally occurring and were formed as a result of borrow pit excavations (Geo-Marine, 2001).

Surface waters at Dam Neck Annex consist of approximately 51 acres of Redwing Lake in the northern portion of the installation; Sadler Pond, in the central portion; and several small ponds such as Lotus Pond, Lilly Pond, and areas of open water that are associated with the extensive marsh system. Lake Tecumseh, also known as Brinson Lake Inlet, forms the southern boundary of Dam Neck Annex. Redwing Lake and Lake Tecumseh are connected through open drainage channels and are connected to Back Bay. Surface waters on Dam Neck Annex are joined to off-base water bodies by a number of drainage canals. Surface water flows from Dam Neck Annex to the south into Black Gut, Back Bay, North Bay, and Shipps Bay (Malcolm Pirnie, 2008).

Surface waters at NALF Fentress consist of extensive wetlands, a network of artificial drainages, and channeled streams, including a major portion of Pacaty Creek. (Malcolm Pirnie, 2008).

2.3 Geology

The MRP sites lie within the Atlantic Coastal Plain physiographic province, which is underlain with unconsolidated sediments generally of Quaternary ages. These surficial deposits include undivided sand, clay, gravel, and peat, which were deposited in marine, fluvial, aeolian, and lacustrine environments (Malcolm Pirnie, 2008).

2.4 Previous Investigations

A Preliminary Assessment (PA) was conducted for the six MRP sites to identify possible munitions and explosives of concern and any sources of MC-related contamination at the sites. Consistent with expected results for a small-caliber munitions site, the PA did not identify any munitions and explosives of concern. However, the PA identified potential MC-related contamination from lead (projectiles), antimony (added to increase projectile hardness), arsenic (small amount present in lead during production), copper (jacket alloy metal), nickel, zinc (jacket alloy metal), and polycyclic aromatic hydrocarbons (PAHs) (associated with clay targets at the skeet and trap range only) (Malcolm Pirnie, 2008).

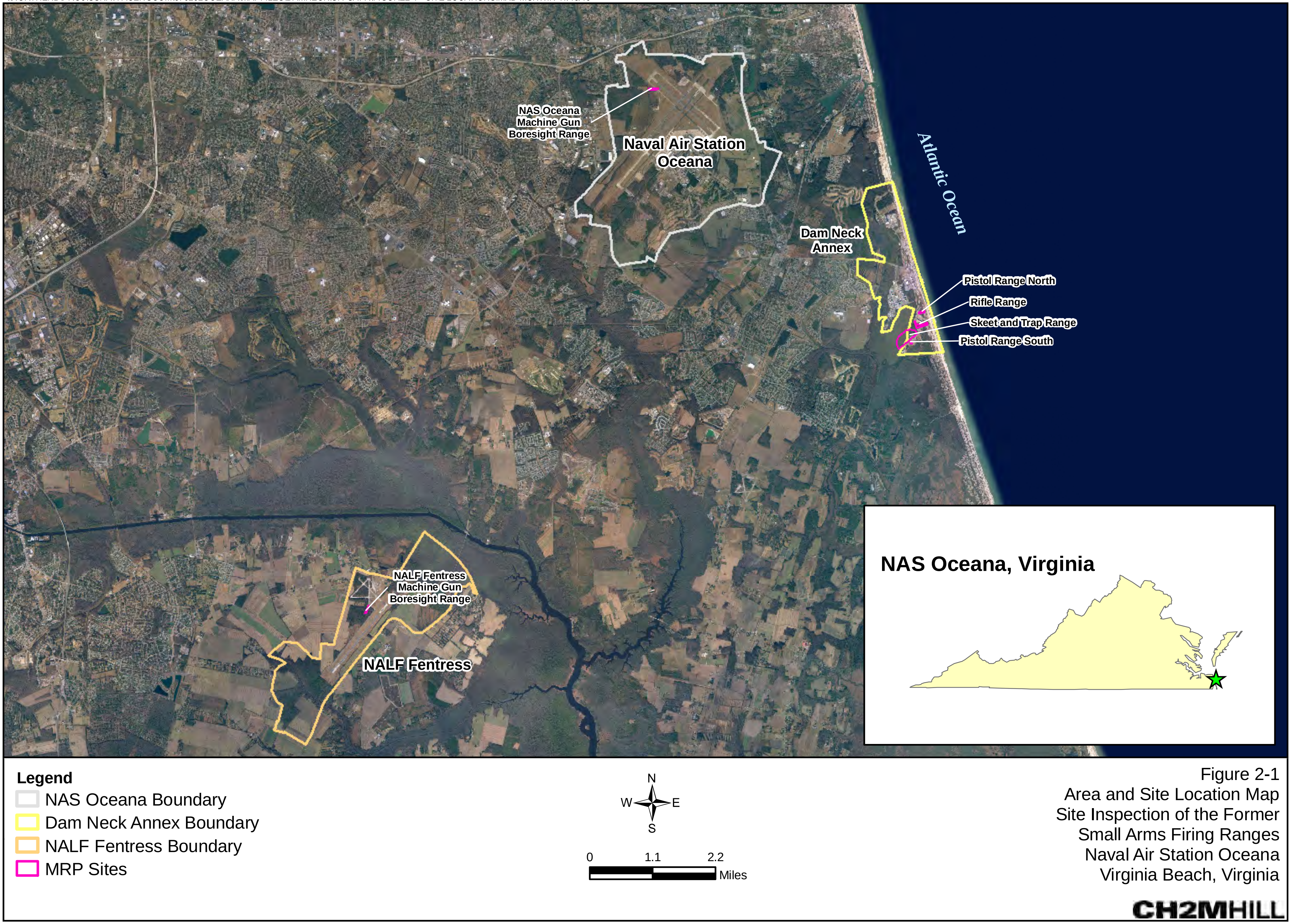

Figure 2-1
Area and Site Location Map
Site Inspection of the Former
Small Arms Firing Ranges
Naval Air Station Oceana
Virginia Beach, Virginia

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SECTION 3

Field Investigation and Data Analysis

Two field investigations were conducted at the six former small arms firing ranges in accordance with the Uniform Federal Policy – Sampling and Analysis Plan (UFP-SAP) (CH2M HILL, 2010). From June 14 through 18, 2010, initial SI field activities were conducted at all small arms firing ranges. Between May 9 through 11, 2011, additional field activities were conducted at the Dam Neck Annex Skeet and Trap Range for the revised SI. SI field work included a utility locate, sample location marking using a GPS, and soil and sediment sampling activities. Investigation methods are summarized as follows.

Site-specific background, sampling rationale, field activities, release assessment decision analysis, and summary and conclusions for each of the six ranges are discussed in Sections 4 through 9. The field notes and chain-of-custody records are provided in **Appendix A**.

3.1 Utility Locate

On June 11, 2010, Accumark identified and marked all subsurface utilities that lie within the bounds of the four former small arms firing ranges at the Dam Neck Annex, including the Pistol Range North, Pistol Range South, Rifle Range, and Skeet and Trap Range sites. A utility locate was not performed at the Machine Gun Boresight Range sites at NAS Oceana and NALF Fentress because the samples were not collected below ground surface (bgs).

On May 6, 2011, Miss Utility identified and marked all subsurface utilities that lie within the bounds of the Skeet and Trap Range at Dam Neck Annex.

3.2 Visual Survey

Soil sampling areas were visually inspected for evidence of past site use related to military munitions. The surveys included inspecting the ground surface for spent shell casings and other range-related debris that may serve as continuing sources of contamination at each site.

3.3 All-Metals Detector Survey

During the 2010 field activities, an all-metals detector field survey was conducted at the sites with accessible areas that could be traversed without damaging or removing vegetation in order to identify areas containing metallic debris suspected to be associated with the use of small arms ammunition. The metal detector survey was conducted throughout the accessible limits of the Rifle Range, Pistol Range South, and Pistol Range North sites. A metal detector survey was not completed at the Skeet and Trap Range and Machine Gun Boresight Ranges at NAS Oceana and NALF Fentress because of densely vegetated and inaccessible areas.

Before samples were collected, a White's XLT all-metals detector was used to sweep the surface in the vicinity of each sampling point to locate any ferrous and non-ferrous material that may have been present. Daily functional checks were performed by passing the detector over a known metallic object on the ground surface to confirm the equipment was working properly.

3.4 Sample Collection

Sample location coordinates were collected using a GPS. All relevant site-specific observations, onsite conditions, and sampling activities were logged in the field notebook. Because the source of contamination was expected to be surficial at each of the sites, most soil samples were collected from 0-12 inches bgs, while the sediment samples were collected from the top 6 inches. A stainless-steel trowel and hand auger were used to collect the soil and sediment samples. At the sites where metallic debris was visually identified, it was confirmed that the planned sample locations were within the areas containing metallic debris. The soil was visually inspected for debris during the collection process before the laboratory-supplied bottleware was filled.

Each sample location was uniquely identified by an alphanumeric code based on the location's attributes:

- Facility (O= Oceana, DN=Dam Neck Annex, F=NALF Fentress)
- Site (MGBR=Machine Gun Boresight Range, PRN=Pistol Range North, PRS=Pistol Range South, RR=Rifle Range, STR=Skeet and Trap Range)
- Media (SO = soil, SD = sediment)
- Sequential location number
- Date, and, as applicable, any additional qualifiers for quality control (QC) (P = duplicate sample, MS = matrix spike, MSD = matrix spike duplicate) samples

3.5 Laboratory Analysis

Samples were contained in laboratory-supplied glassware, packaged, and shipped to Empirical Laboratories every evening under chain-of-custody procedures.

The laboratory analyzed project samples for various groups of parameters, including select metals (lead, antimony, arsenic, copper, nickel, and zinc) and PAHs.

3.6 Data Validation

The analytical data were validated by an internal CH2M HILL project chemist. The data validation reports are provided in **Appendix B**. The data validator used analytical methods and laboratory standard operating procedures to evaluate compliance against quality assurance (QA)/ QC criteria derived from the *Department of Defense (DoD) Quality Systems Manual (QSM) for Environmental Laboratories* , (DoD, 2009). If adherence to QA/QC criteria yielded deficiencies, data were qualified using the qualifiers presented in *Region 3 Modifications to the National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration*, (USEPA, 1994) and *Region 3 Modifications to the National Functional Guidelines for Inorganic Analyses*, (USEPA, 1993). National functional guidelines were not used for data validation; however, the specific qualifiers listed therein may have been applied to data if non-conformances against the QA/QC criteria were identified.

In addition to data validation, a CH2M HILL project chemist performed additional reviews on the analytical data before database loading, in accordance with UFP-SAP Worksheets #35 and 36. All data met review requirements.

Data validation qualifiers and duplicate samples were handled as follows:

- All results qualified as estimated (J/UJ), biased high (K), or biased low (L/UL) were considered usable but estimated. J-, K-, and L-qualified data were treated as unqualified detected concentrations. UJ- and UL-qualified data were treated as non-detected concentrations due to estimated quantitation limits and biased low quantitation limits, respectively.
- All results qualified as B (not detected substantially above the level reported in laboratory or field blanks) were treated as non-detects due to blank contamination.
- All R-qualified results were classified as unreliable and not usable.
- When more than one qualifier was associated with a compound, the validator chose the qualifier that best indicated possible bias in the results and flagged the data accordingly.
- For duplicate samples, the maximum concentration between the two samples was used as the sample concentration.

See **Appendix C**, Data Quality Evaluation, for a summary of all data qualifications and their impacts on data usability.

Potential biases, unreliable data, and non-detect results above the project action limit (PAL) may affect how the project team used the analytical results. In some cases, data qualifications indicate high or low biases that were denoted by the data validator applying K- or L-qualifiers, respectively. Additionally, data may be R-qualified as "unreliable" to indicate an extreme bias due to a QC failure. A non-detect result at a concentration higher than the associated PAL, indicates that the laboratory could not detect that analyte at a level low enough to compare to the PAL. There were no instances of non-detects that were greater than the PAL in this dataset. **Table 3-1** indicates potentially affected data that were relatively close to the associated PAL.

3.7 Decision Analysis Process

The validated results were evaluated using the decision points and actions summarized on **Figure 3-1** to determine if a release posing potential risk has occurred at the six sites. The decision analysis process consists of the following steps.

Step 1

The detected constituent concentrations in the soil and/or sediment at each site were compared to the United States Environmental Protection Agency (USEPA) residential soil Regional Screening Levels (RSLs) (USEPA, 2010a) (**Table 3-2**) and the Ecological Soil Screening Levels (Eco-SSLs) (**Table 3-3**). The detected constituent concentrations in sediment at the Skeet and Trap Range were compared to 10 times the USEPA residential soil RSLs (USEPA, 2011) (10 times the values in **Table 3-2**). Ten times the residential soil RSLs was used for sediment screening following USEPA Region 3 guidance because exposure to sediment is expected to be significantly less than exposure to soil, and there are no human health screening levels specifically for sediment. For PAHs in soil, the Eco-SSLs consist of a screening value for high molecular weight (HMW) PAHs and low molecular weight (LMW) PAHs but not for individual PAH compounds. The RSLs based on noncarcinogenic effects were divided by 10 to account for exposure to multiple constituents that may affect the same target organ. Site-specific results are presented in Sections 4 through 9. Sediment ecological screening values were also developed for lead and PAHs and are discussed in Section 3.9.2. The screening of sediment data at the Skeet and Trap Range followed a similar process as described for soil.

If detected concentrations were not greater than both the RSLs and Eco-SSLs, the decision analysis followed the path to Step 1a. If the concentrations were greater than the RSL or Eco-SSL, the decision analysis followed the path to Step 2.

Step 1a

The historical and spatial distributions of data were evaluated to determine if the potential source area was sufficiently sampled.

Step 2

More-realistic evaluations of the data, including Human Health Risk Screenings (HHRSs) and Ecological Risk Screenings (ERSs), were performed as summarized in Sections 3.8 and 3.9. Site-specific results are summarized in Sections 4 through 9.

If chemicals of potential concern (COPCs) were not identified, the decision analysis followed the path to Step 1a. If COPCs were identified, the decision analysis followed the path to Step 3.

Step 3

In Step 3, the soil COPCs identified in Step 2 were compared to the established background values for eastern Virginia (Gustavsson et al., 2001) and the eastern United States (Shacklette et al., 1984) (**Table 3-4**). The background values are based on regional data, and more site- specific data may result in higher background concentrations. These background values were used in lieu of collecting site-specific background samples, in consultation with the Virginia Department of Environmental Quality on November 9, 2010.

3.8 Human Health Risk Evaluation

A conservative HHRS was performed to evaluate the potential for human health risks associated with exposure to soil at each of the small arms firing ranges and exposure to sediment at the Dam Neck Annex former Skeet and Trap Range. The results of the HHRS provided a preliminary indication of potential risks from exposure to the COPCs identified for each site and were used to help determine whether the sites require further evaluation (such as a baseline risk assessment or additional data collection) or whether future unrestricted (residential) use of the site is acceptable based on human health risks.

3.8.1 Human Health Conceptual Site Model

The human health conceptual site model (CSM) presents an overview of site conditions, potential contaminant migration pathways, and exposure pathways to potential receptors. The human health CSM for soil for the six sites and sediment for the former Skeet and Trap Range is presented on **Figure 3-2**. Sections 4 though 9 present the background for each site.

Potential current receptors at the small arms firing ranges vary for each site, based on current site use, but may include recreational users/visitors, trespassers, maintenance workers, and industrial workers. The potential current receptors may come in contact with surface soil; exposure routes may include incidental ingestion of and dermal contact with the surface soil, and inhalation of particulate emissions from the surface soil. No volatile organic compounds were analyzed for the surface soil because they are not expected to be present based on historical use of the sites as small arms firing ranges. The potential current receptors at the former Skeet and Trap Range may also be exposed to sediment through incidental ingestion and dermal contact.

Potential future receptors include the current receptors, future residents, and construction workers. Future receptors could be exposed to surface soil and subsurface soil (if applicable[1]) if future industrial facilities, piping/utilities, or residential houses are constructed at the sites. Exposure routes for future exposure to the surface and subsurface soil are the same as those for current surface soil—incidental ingestion of and dermal contact with the soil and inhalation of particulate emissions from the soil.

3.8.2 HHRS Methodology

The HHRS for each site was conducted in three steps using a risk ratio technique (Navy, 2000). If COPCs were identified after Step 1, the COPCs were evaluated in Step 2. If COPCs were identified after Step 2, the COPCs were evaluated in Step 3. The HHRS evaluations for each of the six sites are presented in Sections 4 through 9. The three-step screening process is described as follows:

Step 1

The maximum detected constituent concentrations in surface soil and subsurface soil (if applicable) at each site were compared to the USEPA residential soil RSLs. RSLs based on noncarcinogenic effects were divided by 10 to account for exposure to multiple constituents (that is, were adjusted to a hazard quotient (HQ) of 0.1 from the HQ of 1.0 used on the USEPA RSL table). RSLs based on carcinogenic endpoints were used as presented in the **Table 3-1** and are based on a carcinogenic risk of 1×10^{-6}.

Residential receptors are the most conservative potential receptors. Residential soil RSLs are more conservative (lower) than industrial soil RSLs and are therefore protective of all potential receptors (recreational users, visitors, trespassers, residents, industrial workers, and construction workers). Therefore, if the maximum detected concentration was greater than the residential soil RSL, the constituent was identified as a COPC and the screening-level risk evaluation proceeded to Step 2.

The maximum detected constituent concentrations in sediment at the former Skeet and Trap Range were compared to 10 times the USEPA residential soil RSLs. This was done following USEPA Region 3 guidance because exposure to sediment is expected to be significantly less than exposure to soil, and there are no human health

[1] Subsurface soil was sampled only at NAS Oceana Machine Gun Boresight Range and NALF Fentress Machine Gun Boresight Range, the only two sites where the historical site use may have affected the subsurface soil.

screening levels specifically for sediment. RSLs based on noncarcinogenic effects were divided by 10 to account for exposure to multiple constituents (that is, they were adjusted to a HQ of 0.1 from the HQ of 1.0 used on the USEPA RSL table). Therefore, the noncarcinogenic RSLs were used as presented in the RSL table (RSL x 10/10) to screen the sediment data. RSLs based on carcinogenic endpoints are not divided by 10 and are based on a carcinogenic risk of 1×10^{-6}. Therefore, 10 times the RSLs based on carcinogenic endpoints was used to screen the sediment data.

Lead is not evaluated in the same manner as the other COPCs, but is regulated by USEPA based on blood-lead uptake using a physiologically based pharmacokinetic model called the Integrated Exposure Uptake Biokinetic Model. As a screening tool, lead is screened at 400 milligrams per kilogram (mg/kg) in soil and sediment based on residential exposure. The model uses the average lead concentration, not the maximum detected lead concentration. Therefore, if the average lead concentration is greater than 400 mg/kg, lead is identified as a COPC for the site.

Step 2

For constituents identified as COPCs in Step 1, a corresponding risk level was calculated using the following equation:

$$\text{corresponding risk level} = \frac{\text{concentration x acceptable risk level}}{\text{RSL}}$$

The concentration is the maximum detected concentration (the same concentration that was used in Step 1). The acceptable risk level is 1 for noncarcinogens and 10^{-6} for carcinogens. RSLs for noncarcinogenic effects are not adjusted by 10 as was done in Step 1; they are used as presented in **Table 3-2.** All of the corresponding risk levels for each constituent are summed to calculate the cumulative corresponding hazard index (HI) (for noncarcinogens) and cumulative corresponding carcinogenic risk (for carcinogens). A cumulative corresponding HI is also calculated for each target organ/effect. If the cumulative corresponding HI for a target organ/effect is greater than the risk-ratio screening benchmark of 0.5, or the cumulative corresponding carcinogenic risk is greater than the 5×10^{-5} risk-ratio screening benchmark, the chemicals contributing to these values are retained as COPCs and carried forward to Step 3.

Step 3

A corresponding risk level was calculated as previously discussed for Step 2. However, the 95 percent upper confidence limit (UCL) was used in place of the maximum detected concentration, to obtain a more site-specific risk ratio. If the cumulative corresponding HI by target organ/effect is greater than the risk-ratio screening benchmark of 0.5, or the cumulative corresponding carcinogenic risk is greater than the 5×10^{-5} risk-ratio screening benchmark, then chemicals contributing to these values are considered COPCs.

Step 3 was performed only for sites with COPCs from Step 2 and where five or more samples were collected. Five or more samples are needed to perform the statistical calculations necessary to estimate the Step 3 exposure concentration. The most current version of the ProUCL software program (USEPA, 2010b) was used to test the data distribution and calculate 95 percent UCL exposure point concentrations (EPCs) used for the Step 3 risk ratio calculations. In cases where the recommended UCL exceeded the maximum detected concentration, the maximum concentration was used as the EPC.

3.9 Ecological Risk Evaluation

An ERS was performed at each of the six ranges to assess the potential for ecological risks associated with direct exposure to site surface soil (0 to 12 inches bgs) and, where relevant, subsurface soil (12 to 24 inches bgs), and, where applicable, potential ecological risks from terrestrial food web exposures. At the Skeet and Trap Range, an ERS was also performed to assess the potential for ecological risks associated with direct exposure to site surface sediment (0 to 6 inches) and potential ecological risks from aquatic food web exposures. The results of the ERS provided a preliminary indication of potential risks from exposure to the COPCs identified for each site and were used to help decide whether the sites require further evaluation (such as a baseline risk assessment or additional data collection) or if the risks are acceptable.

3.9.1 Ecological CSM

This section summarizes site conditions, potential contaminant migration pathways, and exposure pathways to potential receptors at each Munitions Response Site. Sections 4 through 9 provide details on the background, physical setting, and history of each site.

Machine Gun Boresight Range at NAS Oceana

This 1.7-acre site contains brush, trees, and maintained grass. Complete exposure pathways exist to lower trophic level terrestrial receptors (plants and soil invertebrates). Due to the small size of the area on the site that contains spent ammunition (the backstop [source] area, about 25 feet by 100 feet), exposures to upper trophic level receptors (birds and mammals) are not considered significant and were not evaluated.

Pistol Range North

This 2-acre site is partly developed (roads and parking lots) and partly undeveloped lowland (brush and sand dunes). Complete exposure pathways exist to lower trophic level terrestrial receptors as well as to upper trophic level receptors.

Pistol Range South

This 1-acre site is mostly developed with buildings and parking lots, with the remaining portion of the site covered with maintained grass. Although limited, complete exposure pathways exist to lower trophic level terrestrial receptors in the portion of the site that was sampled (grass areas). Due to the small size of the undeveloped area on the site (less than 0.25 acre), exposures to upper trophic level receptors are not considered significant and were not evaluated.

Rifle Range

This 6-acre site is partly covered by a parking lot, with the remaining portion of the site consisting primarily of forested habitats and the extreme eastern portion of the site encroaching on sand dune/beach habitats. Complete exposure pathways exist to lower trophic level terrestrial receptors as well as to upper trophic level receptors.

Skeet and Trap Range

This 39-acre site is partly developed with buildings and parking lots, with the undeveloped portion of the site consisting of forested habitats and open water (Lake Tecumseh). Complete exposure pathways exist to lower trophic level terrestrial receptors as well as to upper trophic level terrestrial receptors. Complete exposure pathways also exist to lower trophic level aquatic receptors (amphibians, reptiles, fish, and benthic invertebrates), as well as to upper trophic level aquatic receptors (birds and mammals). The Hampton Roads Sanitation District (HRSD) uses the 261-acre lake as a buffer for their Atlantic Treatment Plant.

Machine Gun Boresight Range at NALF Fentress

This 1-acre site contains brush, trees, and maintained grass. Complete exposure pathways exist to lower trophic level terrestrial receptors. Due to the small size of the area on the site that contains spent ammunition (the backstop [source] area, about 25 feet by 100 feet), exposures to upper trophic level receptors are not considered significant and were not evaluated.

3.9.2 Ecological Risk Screening Methodology

The ERS was conducted using a two-step process within the overall decision analysis process presented in Section 3.7, which has three steps. The Ecological Risk Assessment (ERA) process falls within Steps 1 and 2 of this overall process.

If a release is suspected (Step 1 of the overall decision process), site-specific analytical soil results are compared to conservative ecological soil screening values. At the former Skeet and Trap Range, site-specific sediment analytical results are also compared to conservative ecological sediment screening values (freshwater).

The soil samples used in the assessment are listed in **Table 3-5** for each of the six sites. Two types of ecological soil screening values were used depending on the assessment endpoints selected for the site (**Table 3-6**):

- Ecological soil screening values based on lower trophic level receptors, which are contained in **Table 3-3**. Soil screenings using these values were conducted for both surface samples (0 to 12 inches bgs) and, if available, subsurface samples (12 to 24 inches bgs) because ecological exposures for these receptors are generally considered to be confined to the top 2 feet of the soil column.
- Eco-SSLs based upon upper trophic level receptors, which are contained in **Table 3-7**. Only surface soil samples were considered in these screenings.

The sediment samples used in the assessment at the Skeet and Trap Range are also listed in **Table 3-5**. The ecological sediment screening values are listed in **Table 3-8**.

If the maximum detected soil (or sediment) concentration exceeded the ecological screening value, the constituent was retained as an initial COPC. For soil, only chemicals that exceeded the bird/mammal Eco-SSLs were retained for site-specific food web modeling. Site-specific food web modeling used maximum surface soil (or sediment) concentrations, conservative (90th percentile) bioaccumulation factors, and conservative model inputs (food ingestion rates). This constituted Step 1 of the decision process and also corresponds to a screening-level ERA (which is Step 2 of the ERA process outlined in USEPA [1997] and NAVFAC [2003]) guidance).

For the screening value exceedances that are likely attributable to a historical release, an evaluation of the data using more-realistic assumptions was conducted. This more-realistic evaluation (Step 2 of the decision process) was performed to help ensure that an appropriate perspective is considered regarding the release, such that informed decisions on the need for further investigation (such as Step 3 of the decision process, which involves comparing results to background soil data) or action can be made. Step 2 of the decision process corresponds to the first step of a baseline ERA (Step 3a of the ERA process outlined in NAVFAC [2003] guidance).

Where there were exceedances of the ecological screening values in the initial screening, more-realistic evaluations considered the following types of information:

- The size of the site
- The type and quality of the habitat present on the site and in surrounding areas, and the potential receptors likely to be present
- The frequency and magnitude of screening value exceedances
- Average exposure (soil or sediment) concentrations (and, for food web modeling, central tendency estimates for bioaccumulation factors and model inputs)
- The spatial pattern of exceedances
- Additional screening values from the literature, where applicable
- Other site-specific factors that might be relevant to assessing potential exposures (such as soil type, bioavailability, fate, and transport properties)
- Ingestion-based (food web) COPCs were based upon a comparison of mean exposure doses (versus maximum exposure doses for the initial screening step) with ingestion toxicity reference values based upon the No Observed Adverse Effect Level (NOAEL), the Maximum Acceptable Toxicant Concentration (MATC), and the Lowest Observed Adverse Effect Level (LOAEL). The MATC is the geometric mean of the NOAEL and LOAEL. An exceedance of the MATC was generally considered an unacceptable effect at the refined screening step (versus the NOAEL for the initial screening step), although chemicals that exceeded the MATC, but not the LOAEL, were discussed for possible risk management considerations.

When more-realistic evaluations of the data were conducted for a site, the rationale for those evaluations was included in the discussion. It is recognized that these more-realistic evaluations may have uncertainty as a result of the limited amount of data generally available at the SI stage. However, these additional risk evaluations provide yet another line of evidence that, when considered with all other site-specific information and evaluations, increase the level of confidence by which conclusions for each site are drawn.

TABLE 3-1
Analytical Results Close to PAL

Sample	Analyte	Result	PAL	Comment
DNRR-SS06-0610	Antimony	2.19 L mg/kg	3.1 mg/kg (RSL)	Result is biased low and is less than the PAL; actual result may be greater. Results are available for use by project team.
DNSTR-SS07-0610	Benz(a)anthracene	133 L µg/kg	150 µg/kg (RSL)	
OFMGBR-SS08-0610	Zinc	80.2 L mg/kg	120 mg/kg (Ecological PAL)	
DNRR-SS08-0610	Antimony	1.19 R mg/kg	3.1 mg/kg (RSL)	Result is biased extremely low and is less than the PAL; actual result may or may not be greater. Results are not available for project use.
OCMGBR-SB01-0610	Antimony	0.924 R mg/kg	3.1 mg/kg (RSL)	

µg/kg = microgram(s) per kilogram
mg/kg = milligrams per kilogram

TABLE 3-2
USEPA Residential Soil RSLs[1]

Analyte	Residential Soil RSLs Adjusted[2]
Total Metals	**(mg/kg)**
Antimony	3.1
Arsenic	0.39
Copper	310
Lead	400
Nickel	150
Zinc	2,300
Semivolatile Organic Compounds	**(µg/kg)**
2-Methylnaphthalene	31,000
Acenaphthene	340,000
Acenaphthylene[3]	340,000
Anthracene	1,700,000
Benzo(a)anthracene	150
Benzo(a)pyrene	15
Benzo(b)fluoranthene	150

TABLE 3-2
USEPA Residential Soil RSLs[1]

Analyte	Residential Soil RSLs Adjusted[2]
Benzo(g,h,i)perylene[4]	170,000
Benzo(k)fluoranthene	1,500
Chrysene	15,000
Dibenz(a,h)anthracene	15
Fluoranthene	230,000
Fluorene	230,000
Indeno(1,2,3-cd)pyrene	150
Naphthalene	3,600
Phenanthrene[5]	1,700,000
Pyrene	170,000

1. These RSLs were also used for sediment.
2. Residential Soil RSLs are USEPA's residential soil RSLs (adjusted). RSLs based on noncarcinogenic effects are adjusted by dividing by 10 to account for exposure to multiple constituents that may affect the same target organ. RSLs based on carcinogenic endpoints are not adjusted.
3. RSL for acenapththene used as surrogate for acenaphthylene.
4. RSL for pyrene used as surrogate for benzo(g,h,i)perylene.
5. RSL for anthracene used as surrogate for phenanthrene.

TABLE 3-3
Ecological Soil Screening Values for Plants and Soil Invertebrates

Chemical	Screening Value	Units	Reference	Comments
Metals				
Antimony	78.0	mg/kg	USEPA, 2005a	Eco-SSL - Invertebrate
Arsenic	18.0	mg/kg	USEPA, 2005b	Eco-SSL - Plant
Copper	70.0	mg/kg	USEPA, 2007a	Eco-SSL - Plant
Lead	120	mg/kg	USEPA, 2005c	Eco-SSL - Plant
Nickel	38.0	mg/kg	USEPA, 2007b	Eco-SSL - Plant
Zinc	120	mg/kg	USEPA, 2007c	Eco-SSL - Invertebrate
Semivolatile Organic Compounds				
2-Methylnaphthalene	LMW PAH	--	--	
Acenaphthene	LMW PAH	--	--	
Acenaphthylene	LMW PAH	--	--	
Anthracene	LMW PAH	--	--	
Benzo(a)anthracene	HMW PAH	--	--	
Benzo(a)pyrene	HMW PAH	--	--	
Benzo(b)fluoranthene	HMW PAH	--	--	
Benzo(g,h,i)perylene	HMW PAH	--	--	

TABLE 3-3
Ecological Soil Screening Values for Plants and Soil Invertebrates

Chemical	Screening Value	Units	Reference	Comments
Benzo(k)fluoranthene	HMW PAH	--	--	
Chrysene	HMW PAH	--	--	
Dibenz(a,h)anthracene	HMW PAH	--	--	
Fluoranthene	LMW PAH	--	--	
Fluorene	LMW PAH	--	--	
Indeno(1,2,3-cd)pyrene	HMW PAH	--	--	
Naphthalene	LMW PAH	--	--	
PAH (HMW)	18,000	µg/kg	USEPA 2007d	Eco-SSL - Invertebrate
PAH (LMW)	29,000	µg/kg	USEPA 2007d	Eco-SSL - Invertebrate
Phenanthrene	LMW PAH	--	--	
Pyrene	HMW PAH	--	--	

TABLE 3-4
Background Values (Soil)

Analyte	Eastern Virginia (mg/kg)	Eastern US (mg/kg)
Antimony	--	0.52
Arsenic	3.1	--
Copper	--	13
Lead	--	14
Nickel	6	--
Zinc	28	--

TABLE 3-5

Samples Used in the Ecological Risk Screening

Site	Station ID	Sample ID	Date	Depth (inches)
Surface Soil				
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO01	DNPRN-SS01-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO03	DNPRN-SS03-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO04	DNPRN-SS04-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO05	DNPRN-SS05-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO06	DNPRN-SS06-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO07	DNPRN-SS07-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO08	DNPRN-SS08-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO09	DNPRN-SS09-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO10	DNPRN-SS10-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO11	DNPRN-SS11-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO11	DNPRN-SS11P-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO12	DNPRN-SS12-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO13	DNPRN-SS13-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO14	DNPRN-SS14-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO14	DNPRN-SS14P-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO16	DNPRN-SS16-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO16	DNPRN-SS16P-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO17	DNPRN-SS17-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO18	DNPRN-SS18-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO18	DNPRN-SS18P-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO19	DNPRN-SS19-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range North	DNPRN-SO20	DNPRN-SS20-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range South	DNPRS-SO01	DNPRS-SS01-0610	6/14/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range South	DNPRS-SO02	DNPRS-SS02-0610	6/14/2010	0 - 12
FCTC - Dam Neck Annex: Pistol Range South	DNPRS-SO03	DNPRS-SS03-0610	6/14/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO01	DNRR-SS01-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO01	DNRR-SS01P-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO02	DNRR-SS02-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO02	DNRR-SS02P-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO03	DNRR-SS03-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO03	DNRR-SS03P-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO04	DNRR-SS04-0610	6/15/2010	0 - 12

TABLE 3-5
Samples Used in the Ecological Risk Screening

Site	Station ID	Sample ID	Date	Depth (inches)
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO04	DNRR-SS04P-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO05	DNRR-SS05-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO05	DNRR-SS05P-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO06	DNRR-SS06-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO07	DNRR-SS07-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO08	DNRR-SS08-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO09	DNRR-SS09-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO10	DNRR-SS10-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO11	DNRR-SS11-0610	6/16/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO12	DNRR-SS12-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO13	DNRR-SS13-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO14	DNRR-SS14-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO15	DNRR-SS15-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO15	DNRR-SS15P-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO16	DNRR-SS16-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO17	DNRR-SS17-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO18	DNRR-SS18-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO19	DNRR-SS19-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO20	DNRR-SS20-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO21	DNRR-SS21-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Rifle Range	DNRR-SO22	DNRR-SS22-0610	6/15/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO01	DNSTR-SS01-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO02	DNSTR-SS02-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO03	DNSTR-SS03-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO04	DNSTR-SS04-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO05	DNSTR-SS05-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO06	DNSTR-SS06-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO07	DNSTR-SS07-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO08	DNSTR-SS08-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO09	DNSTR-SS09-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO10	DNSTR-SS10-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO11	DNSTR-SS11-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO12	DNSTR-SS12-0610	6/17/2010	0 - 12

TABLE 3-5

Samples Used in the Ecological Risk Screening

Site	Station ID	Sample ID	Date	Depth (inches)
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO13	DNSTR-SS13-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO14	DNSTR-SS14-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO15	DNSTR-SS15-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO16	DNSTR-SS16-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO17	DNSTR-SS17-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO18	DNSTR-SS18-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO19	DNSTR-SS19-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO20	DNSTR-SS20-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SO21	DNSTR-SS21-0610	6/17/2010	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SS22	DNSTR-SS22-0511	5/11/2011	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SS23	DNSTR-SS23-0511	5/11/2011	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SS24	DNSTR-SS24-0511	5/11/2011	0 - 12
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SS25	DNSTR-SS25-0511	5/11/2011	0 - 12
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO01	OCMGBR-SS01-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO02	OCMGBR-SS02-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO03	OCMGBR-SS03-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO04	OCMGBR-SS04-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO05	OCMGBR-SS05-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO06	OCMGBR-SS06-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO07	OCMGBR-SS07-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO08	OCMGBR-SS08-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO01	OFMGBR-SS01-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO02	OFMGBR-SS02-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO03	OFMGBR-SS03-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO04	OFMGBR-SS04-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO05	OFMGBR-SS05-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO06	OFMGBR-SS06-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO07	OFMGBR-SS07-0610	6/18/2010	0 - 12
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO08	OFMGBR-SS08-0610	6/18/2010	0 - 12
Subsurface Soil				
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO01	OCMGBR-SB01-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO02	OCMGBR-SB02-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO03	OCMGBR-SB03-0610	6/18/2010	12 - 24

TABLE 3-5

Samples Used in the Ecological Risk Screening

Site	Station ID	Sample ID	Date	Depth (inches)
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO04	OCMGBR-SB04-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO05	OCMGBR-SB05-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO06	OCMGBR-SB06-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO07	OCMGBR-SB07-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NAS Oceana)	OCMGBR-SO08	OCMGBR-SB08-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO01	OFMGBR-SB01-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO02	OFMGBR-SB02-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO03	OFMGBR-SB03-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO04	OFMGBR-SB04-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO05	OFMGBR-SB05-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO06	OFMGBR-SB06-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO07	OFMGBR-SB07-0610	6/18/2010	12 - 24
Machine Gun Boresight Range (NALF Fentress)	OFMGBR-SO08	OFMGBR-SB08-0610	6/18/2010	12 - 24
Surface Sediment				
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD01	DNSTR-SD01-0511	5/9/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD01	DNSTR-SD01P-0511	5/9/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD02	DNSTR-SD02-0511	5/9/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD03	DNSTR-SD03-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD04	DNSTR-SD04-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD05	DNSTR-SD05-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD06	DNSTR-SD06-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD07	DNSTR-SD07-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD08	DNSTR-SD08-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD09	DNSTR-SD09-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD10	DNSTR-SD10-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD11	DNSTR-SD11-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD12	DNSTR-SD12-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD13	DNSTR-SD13-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD14	DNSTR-SD14-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD15	DNSTR-SD15-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD16	DNSTR-SD16-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD17	DNSTR-SD17-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD17	DNSTR-SD17P-0511	5/10/2011	0 - 6

TABLE 3-5
Samples Used in the Ecological Risk Screening

Site	Station ID	Sample ID	Date	Depth (inches)
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD18	DNSTR-SD18-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD19	DNSTR-SD19-0511	5/10/2011	0 - 6
FCTC - Dam Neck Annex: Skeet and Trap Range	DNSTR-SD20	DNSTR-SD20-0511	5/10/2011	0 - 6
Shaded cells indicate field duplicates				

TABLE 3-6
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Site	Receptor
Terrestrial Habitats				
Survival, growth, and reproduction of terrestrial soil invertebrate communities		Comparison of maximum (initial) and mean (refined) chemical concentrations in surface soil with soil screening values	All	Soil invertebrates
Survival, growth, and reproduction of terrestrial plant communities	Are site-related chemical concentrations in surface soil sufficient to adversely effect terrestrial plant communities?	Comparison of maximum (initial) and mean (refined) chemical concentrations in surface soil with soil screening values	All	Terrestrial plants
Survival, growth, and reproduction of terrestrial reptile populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to terrestrial reptile populations?	Comparison of maximum (initial) and mean (refined) chemical concentrations in surface soil with soil screening values	All	Reptiles
		Evidence of potential risk to other upper trophic level terrestrial receptors evaluated in the ERA (birds and mammals used as surrogates)	Skeet and Trap Range Rifle Range	
Survival, growth, and reproduction of terrestrial avian and mammalian invertivore populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian and mammalian receptor populations that may consume soil invertebrates from the site?	Comparison of modeled dietary intakes using maximum (initial) and mean (refined) surface soil concentrations with literature-based ingestion TRVs; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Skeet and Trap Range Rifle Range	Short-tailed shrew American robin
Survival, growth, and reproduction of terrestrial avian and mammalian herbivore populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian and mammalian receptor populations that may consume terrestrial plants from the site?	Comparison of modeled dietary intakes using maximum (initial) and mean (refined) surface soil concentrations with literature-based ingestion TRVs; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Skeet and Trap Range Rifle Range	Meadow vole Mourning dove
Survival, growth, and reproduction of terrestrial avian and mammalian carnivore populations	Are site-related chemical concentrations in surface soil sufficient to cause adverse effects (on growth, survival, or reproduction) to avian and mammalian receptor populations that may consume small mammals from the site?	Comparison of modeled dietary intakes using maximum (initial) and mean (refined) surface soil concentrations with literature-based ingestion TRVs; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Skeet and Trap Range Rifle Range	Red fox Red-tailed hawk

TABLE 3-6
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Site	Receptor
Aquatic Habitats				
Survival, growth, and reproduction of benthic invertebrate communities	Are site-related chemical concentrations in surface sediment sufficient to adversely effect benthic invertebrate communities?	Comparison of maximum (initial) and mean (refined) chemical concentrations in surface sediment with sediment screening values	Skeet and Trap Range	Benthic invertebrates
Survival, growth, and reproduction of aquatic plant communities	Are site-related chemical concentrations in surface sediment sufficient to adversely affect aquatic plant communities?	Comparison of maximum (initial) and mean (refined) chemical concentrations in surface sediment with sediment screening values	Skeet and Trap Range	Aquatic plants
Survival, growth, and reproduction of fish communities	Are site-related chemical concentrations in surface sediment sufficient to adversely effect fish communities?	Comparison of maximum (initial) and mean (refined) chemical concentrations in surface sediment with sediment screening values	Skeet and Trap Range	Fish
Survival, growth, and reproduction of aquatic amphibian populations	Are site-related chemical concentrations in surface sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to aquatic amphibian populations?	Comparison of maximum (initial) and mean (refined) chemical concentrations in surface sediment with sediment screening values	Skeet and Trap Range	Amphibians
		Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA (birds and mammals used as surrogates)	Skeet and Trap Range	
Survival, growth, and reproduction of aquatic reptile populations	Are site-related chemical concentrations in surface sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to reptile amphibian populations?	Comparison of maximum (initial) and mean (refined) chemical concentrations in surface sediment with sediment screening values	Skeet and Trap Range	Reptiles
		Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA (birds and mammals used as surrogates)	Skeet and Trap Range	
Survival, growth, and reproduction of insectivorous bird populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian receptor populations that may consume benthic invertebrates from the site?	Comparison of modeled dietary intakes using maximum (initial) and mean (refined) surface sediment concentrations with literature-based ingestion TRVs; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Skeet and Trap Range	Marsh wren
Survival, growth, and reproduction of piscivorous bird populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian receptor populations that may consume fish from the site?	Comparison of modeled dietary intakes using maximum (initial) and mean (refined) surface sediment concentrations with literature-based ingestion TRVs; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Skeet and Trap Range	Great blue heron Belted kingfisher

TABLE 3-6
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Site	Receptor
Survival, growth, and reproduction of omnivorous bird populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian receptor populations that may consume aquatic prey from the site?	Comparison of modeled dietary intakes using maximum (initial) and mean (refined) surface sediment concentrations with literature-based ingestion TRVs; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Skeet and Trap Range	Mallard
Survival, growth, and reproduction of herbivorous mammal populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume aquatic plants from the site?	Comparison of modeled dietary intakes using maximum (initial) and mean (refined) surface sediment concentrations with literature-based ingestion TRVs; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Skeet and Trap Range	Muskrat
Survival, growth, and reproduction of omnivorous mammal populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume aquatic prey from the site?	Comparison of modeled dietary intakes using maximum (initial) and mean (refined) surface sediment concentrations with literature-based ingestion TRVs; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Skeet and Trap Range	Raccoon
Survival, growth, and reproduction of piscivorous mammal populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume fish from the site?	Comparison of modeled dietary intakes using maximum (initial) and mean (refined) surface sediment concentrations with literature-based ingestion TRVs; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Skeet and Trap Range	Mink

TABLE 3-7
Eco-SSL Values for Birds and Mammals

Chemical	Bird	Mammal	Units	Reference
Metals				
Antimony	--	0.27	mg/kg	USEPA 2005a
Arsenic	43.0	46.0	mg/kg	USEPA 2005b
Copper	28.0	49.0	mg/kg	USEPA 2007a
Lead	11.0	56.0	mg/kg	USEPA 2005c
Nickel	210	130	mg/kg	USEPA 2007b
Zinc	46.0	79.0	mg/kg	USEPA 2007c
Organics				
PAHs - LMW	--	100	mg/kg	USEPA 2007d
PAHs - HMW	--	1.10	mg/kg	USEPA 2007d

TABLE 3-8
Ecological Sediment Screening Values (Freshwater)

Chemical	Screening Value	Units	Reference	Comments
Metals				
Lead	35.8	mg/kg	MacDonald et al. 2000	TEC
Semivolatile Organic Compounds				
2-Methylnaphthalene	20.2	ug/kg	MacDonald 1994	TEL (marine)
Acenaphthene	290	ug/kg	Buchman 2008	UET
Acenaphthylene	160	ug/kg	Buchman 2008	UET
Anthracene	57.2	ug/kg	MacDonald et al. 2000	TEC
Benzo(a)anthracene	108	ug/kg	MacDonald et al. 2000	TEC
Benzo(a)pyrene	150	ug/kg	MacDonald et al. 2000	TEC
Benzo(b)fluoranthene	240	ug/kg	Benzo(k)fluoanthene value	
Benzo(g,h,i)perylene	170	ug/kg	Persuad et al. 1993	LEL
Benzo(k)fluoranthene	240	ug/kg	Persuad et al. 1993	LEL
Chrysene	166	ug/kg	MacDonald et al. 2000	TEC
Dibenz(a,h)anthracene	33.0	ug/kg	MacDonald et al. 2000	TEC
Fluoranthene	423	ug/kg	MacDonald et al. 2000	TEC
Fluorene	77.4	ug/kg	MacDonald et al. 2000	TEC
Indeno(1,2,3-cd)pyrene	200	ug/kg	Persuad et al. 1993	LEL
Naphthalene	176	ug/kg	MacDonald et al. 2000	TEC
PAH (HMW)	2,900	ug/kg	Jones et al. 1997	ARCS TEC
PAH (LMW)	786	ug/kg	Jones et al. 1997	ARCS TEC
PAH (total)	3,553	ug/kg	Jones et al. 1997	ARCS TEC
Phenanthrene	204	ug/kg	MacDonald et al. 2000	TEC
Pyrene	195	ug/kg	MacDonald et al. 2000	TEC

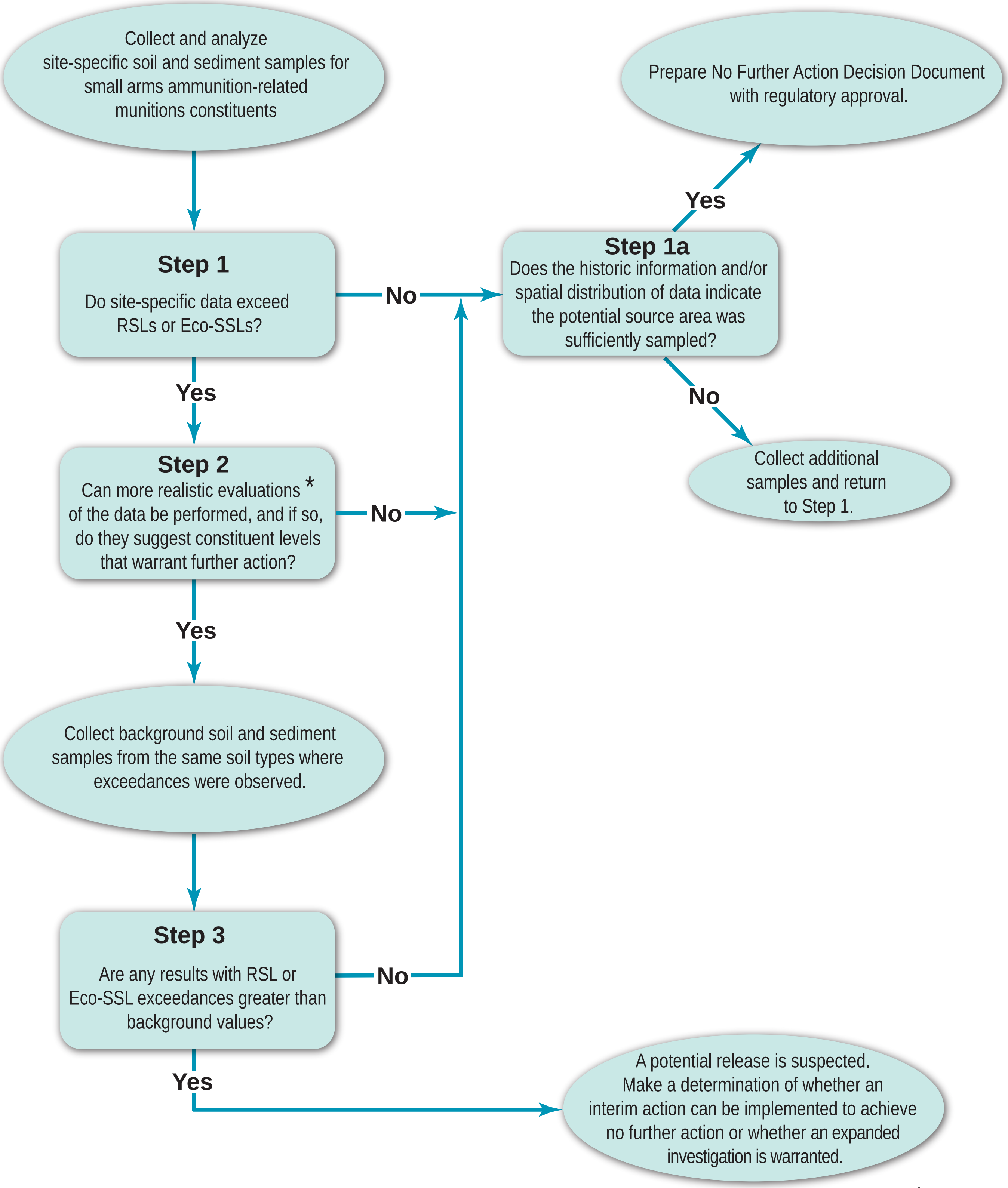
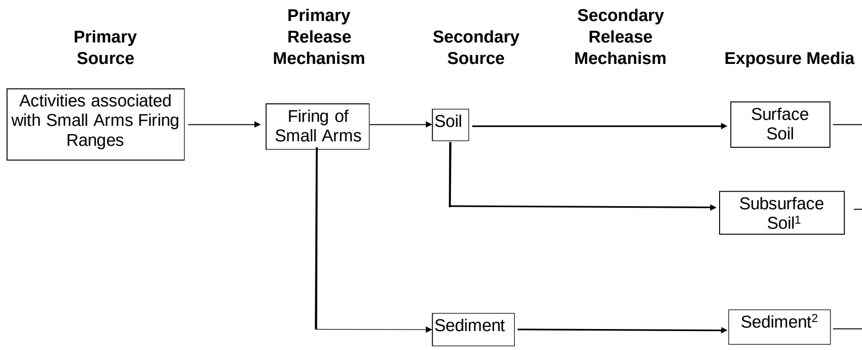


Figure 3-1
SI Evaluation Decision Tree
Site Inspection of the Former
Small Arms Firing Ranges
Naval Air Station Oceana
Virginia Beach, Virginia

* See Worksheet #11 of the UFP-SAP for examples of more realistic evaluations



Potential Human Receptors

Exposure Route	Current/Future				Future	
	Visitors/ Recreational Users	Trespassers	Maintenance Worker	Industrial Worker	Residents	Construction Worker
Ingestion	●	●	●	●	●	●
Dermal Contact	●	●	●	●	●	●
Inhalation	●	●	●	●	●	●
Ingestion	●	●	●	●	●	●
Dermal Contact	●	●	●	●	●	●
Inhalation	●	●	●	●	●	●
Ingestion	●	●	●	●	NA	NA
Dermal Contact	●	●	●	●	NA	NA
Inhalation	NA	NA	NA	NA	NA	NA

[1] Subsurface soil evaluated for NAS Oceana Machine Gun Boresight Range and NALF Fentress Machine Gun Boresight Range. Exposure to subsurface soil only a potential complete exposure pathway for future scenarios.
[2] Sediment evaluated for Skeet and Trap Range
● Potentially complete exposure pathways
NA Not applicable or pathway is incomplete

FIGURE 3-2
Conceptual Site Model for HHRA
Former Small Arms Firing Ranges
Naval Air Station Oceana

SECTION 4

NAS Oceana: Machine Gun Boresight Range

4.1 Site Background

The former Machine Gun Boresight Range at NAS Oceana covers approximately 1.7 acres and is north of Dorr Place and west of Runway 14 (**Figure 4-1)**. The eastern half of the site is generally flat and consists of maintained grass because it borders an active aircraft runway. The western portion, however, is predominantly overgrown with brush and trees because it is not actively used by the installation. According to an archival map from 1943, the site was initially used as a maintenance and testing range for aircraft-mounted machine guns and was later converted to a small arms firing range (Malcolm Pirnie, 2008). A concrete backstop is still in place on the western portion of the site, which suggests that the direction of fire was toward the west. The concrete backstop is overgrown with trees and brush and is deteriorating. The former firing point is approximately 900 feet east of the backstop (Malcolm Pirnie, 2008), as shown on **Figure 4-1**. There are no wetlands or water bodies on the site.

Ammunition used at the former Machine Gun Boresight Range was likely limited to .50 and .30 caliber rounds for aircraft guns, as well as 9-millimeter (mm) rounds for small arms. Potential MC related to small arms ammunition are lead, antimony, arsenic, copper, nickel, and zinc (Malcolm Pirnie, 2008). Based on the nature of the munitions likely to have been used onsite, the potential source of contamination is suspected to be within the top 24 inches of the surface. Although the distribution of small arms ammunition debris within the former range is not known, it is suspected that the greatest density would be present in the backstop.

4.2 Rationale for Investigation

Potential sources of contamination present at the former range are debris related to small arms ammunition. It was concluded that surface and subsurface soils are the medium most likely to be contaminated based on the use of the range. Because groundwater in this area is not anticipated to be affected, the SI did not evaluate groundwater as a potential route of exposure. There is no surface water or sediment present onsite.

4.3 Field Activities

4.3.1 Visual Survey

During the sampling event, the sampling area was visually inspected, as described in Section 3.2.

During the inspection, numerous .223 caliber small arms projectiles and jackets were found on the ground surface of the entire berm. Significant bullet scarring was observed across the length of the backstop.

4.3.2 Sample Collection

Discrete surface and subsurface soil samples were collected from eight locations from the berm of the backstop, as shown on **Figure 4-1**, to obtain samples equally distributed across the anticipated contaminated area because the entire berm looked equally affected by range activities. Subsurface samples were dug following the trajectory of the bullet (horizontally) into the berm instead of vertically. Samples were analyzed for lead, antimony, arsenic, copper, nickel, and zinc.

4.4 Release Assessment Decision Analysis

Data for the samples collected during the field investigations were evaluated in accordance with the decision logic presented on **Figure 3-1** and approved by the project team during development of the UFP-SAP (CH2M HILL, 2010). The following subsections describe the steps in the decision process, analytical results, and an evaluation of potential risks at this former range.

Table 4-1 presents an exceedance summary of the sample results. **Table 4-2**, presented at the end of this section, contains the validated analytical results of the sample investigation. The results were compared to the following screening values: RSLs for residential soil and Eco-SSLs for plants and soil invertebrates, as described in Sections 3.8 and 3.9. The exceedance results are presented on **Figure 4-2**.

Sections 4.4.1 through 4.4.3 summarize the results associated with each step of the decision analysis.

TABLE 4-1
Machine Gun Boresight Range Exceedance Summary

Total Number of Samples	Analyte	Units	Max Value	Residential Soil RSL	Number of Residential Soil RSL Exceedances	ECO-SSL	Number of ECO-SSL Exceedances
8 (SS)	Antimony	mg/kg	13.1	3.1	5/8	78	0/8
	Arsenic	mg/kg	5.36	0.39	8/8	18	0/8
	Copper	mg/kg	4,310	310	4/8	70	6/8
	Lead	mg/kg	19,500	400	7/8	120	8/8
	Zinc	mg/kg	524	2,400	0/8	120	3/8
8 (SB)	Antimony	mg/kg	57.1	3.1	2/8	78	0/8
	Arsenic	mg/kg	4.96	0.39	8/8	18	0/8
	Copper	mg/kg	1,060	310	3/8	70	6/8
	Lead	mg/kg	16,000	400	6/8	120	7/8
	Zinc	mg/kg	281	2,400	0/8	120	3/8

SS= surface; SB= subsurface

4.4.1 Step 1

Eight surface and eight subsurface samples were collected from each of the eight sampling locations at the range during the field sampling activities. In Step 1, the sample results were compared to the human health and ecological screening levels. As shown on **Table 4-1**, sample results exceeded the screening levels for all eight locations and five metals.

On the basis of these exceedances, the decision analysis followed the path to Step 2.

4.4.2 Step 2

Because of the magnitude of the exceedances, more-realistic evaluations of the data were undertaken to decide if further action would be necessary. Potential ecological and human health risks were evaluated. The results of these evaluations are discussed as follows.

HHRS Results

The risk-based screening evaluation for surface soil and subsurface soil at NAS Oceana Boresight Range is presented in **Tables 4-3 through 4-4b**.

Surface Soil

Tables 4-3 through 4-3b present the risk-based screening evaluation for surface soil. Four metals (antimony, arsenic, copper, and lead) were identified as COPCs in Step 1 and were retained for evaluation in Step 2. Based on Step 2 (risk ratio using maximum detected concentrations), copper was carried forward to Step 3. Based on Step 3 (risk ratio using 95 percent UCLs), copper could not be eliminated and was retained as a COPC for surface soil. The potential risk associated with exposure to copper in surface soil is associated with two of the samples, OCMGBR-SS05-0610 and OCMGBR-SS06-0610.

The average lead concentration in the surface soil is 6,642 mg/kg, which exceeds the lead screening level. Lead and copper are considered COPCs for surface soil.

Subsurface Soil

Tables 4-4 through 4-4b present the risk-based screening evaluation for subsurface soil. Four metals (antimony, arsenic, copper, and lead) were identified as Step 1 COPCs and were retained for evaluation in Step 2. Based on Step 2 (risk ratio using maximum detected concentrations), antimony was carried forward to Step 3. Based on Step 3 (risk ratio using 95 percent UCLs), antimony could not be eliminated and was retained as a COPC for subsurface soil. The potential risk associated with exposure to antimony in subsurface soil is associated with only one of the samples, OCMGBR- SB05-0610.

The average lead concentration in the subsurface soil is 3,031 mg/kg, which exceeds the lead screening level. Lead, along with antimony, is considered a COPC for subsurface soil.

HHRS Results Summary

Based on the HHRS evaluation for NAS Oceana Machine Gun Boresight Range, potential unacceptable risks were identified for both surface soil and subsurface soil. In order to assess the risk based on anticipated receptors (recreational users/visitors, trespassers, maintenance workers, and industrial workers) a more-quantitative risk assessment would be needed.

Potential unacceptable risks for surface soil are associated with copper and lead, and for subsurface soil they are associated with antimony and lead. Therefore, the decision analysis proceeded to Step 3 (Section 4.4.3).

Ecological Risk Screening Results

The results of the ecological risk evaluation for the Machine Gun Boresight Range (Oceana) are presented in **Table 4-5** and **Table 4-6**.

Surface Soil

Sample concentrations of copper, lead, and zinc each exceeded ecological soil screening values for plants and soil invertebrates based on maximum detected concentrations (**Table 4-5**). Therefore, these three metals were identified as initial COPCs. HQs based on mean concentrations exceeded 1 for all three metals, substantially so for copper and lead. In particular, lead exceeded screening values in all eight surface soil samples by a factor of 2 or more (**Table 4-6**). Therefore, copper, lead, and zinc were identified as refined COPCs. However, the spatial extent of the potentially affected area is relatively small and is likely confined to the backstop area (about 25 feet by 100 feet).

Subsurface Soil

Copper, lead, and zinc each exceeded ecological soil screening values for plants and soil invertebrates based on maximum detected concentrations (**Table 4-5**). Therefore, these three metals were identified as initial COPCs. HQs based on mean concentrations exceeded 1 for copper and lead. In particular, lead exceeded screening values in seven of eight subsurface soil samples by a factor of 2 or more (**Table 4-6**). Therefore, copper and lead were identified as refined COPCs. However, the spatial extent of the potentially affected area is relatively small and is likely confined to the backstop area.

Ecological Risk Screening Summary

Copper, lead, and zinc were identified as COPCs in surface soil, and copper and lead were also identified as COPCs in subsurface soil. Although the magnitude of the screening value exceedances was relatively high, particularly for lead, the spatial extent of the potentially affected area is relatively small and is likely confined to the backstop area. Therefore, potential unacceptable ecological risks are likely to be spatially limited.

The decision analysis proceeded to Step 3 (Section 4.4.3).

4.4.3 Step 3

Antimony, copper, lead, and zinc were identified as COPCs in Step 2. In Step 3, the COPC concentrations were compared to the established background values for eastern Virginia (presented in Section 3.7). All COPC results exceeded background values, so a potential release is suspected.

4.5 Summary and Conclusions

Concentrations of some range-related MCs were found to exceed human and/or ecological screening values at all soil sampling locations. Based on the HHRS and ecological evaluations, potential unacceptable human health and ecological risks were identified for both surface soil and subsurface soil.

Although the magnitude of the screening value exceedances was relatively high, the spatial extent of the potentially affected area is relatively small and is likely confined to the backstop area. Therefore, potential unacceptable risks are likely to be spatially limited. Because of the relatively small area potentially affected, a soil removal action should be considered. A remedial investigation is recommended to further delineate the lateral and vertical extent of soil contamination and to establish site-specific background levels for the COPCs. In addition, quantitative Human Health Risk Assessments (HHRAs) and ERAs should be conducted to assess risk based on anticipated receptors. The risk assessments then can be used to calculate the risk-based cleanup goals based on anticipated land use. Following the completion of these tasks, the quantity of soils exceeding unacceptable risk/ background levels can be calculated.

TABLE 4-2
Soil Sample Analytical Results, Machine Gun Boresight Range - NAS Oceana
NAS Oceana (CTO-WE03)
June 2010

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	OCMGBR-SO01	OCMGBR-SO02	OCMGBR-SO03	OCMGBR-SO04
Sample ID			OCMGBR-SS01-0610	OCMGBR-SS02-0610	OCMGBR-SS03-0610	OCMGBR-SS04-0610
Sample Date			06/18/10	06/18/10	06/18/10	06/18/10
Chemical Name						
Total Metals (MG/KG)						
Antimony	3.1	78	0.924 U	**4.66**	**7.32**	0.955 U
Arsenic	0.39	18	**1.69**	**2.48**	**1.87**	**1.91**
Copper	310	70	**24.8**	**582**	**187**	**65.5**
Lead	400	120	**239**	**9,210**	**3,770**	**668**
Nickel	150	38	**6.55**	**7.1**	**7.27**	**7.9**
Zinc	2,300	120	**18.3**	**87.6**	**35.3**	**26.5**

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	OCMGBR-SO01	OCMGBR-SO02	OCMGBR-SO03	OCMGBR-SO04
Sample ID			OCMGBR-SB01-0610	OCMGBR-SB02-0610	CMGBR-SB03-0610	OCMGBR-SB04-0610
Sample Date			06/18/10	06/18/10	06/18/10	06/18/10
Chemical Name						
Total Metals (MG/KG)						
Antimony	3.1	78	0.924 R	**4.31**	**0.288 J**	**0.926 J**
Arsenic	0.39	18	**1.62**	**2.81**	**1.84**	**2.24**
Copper	310	70	**4.55 L**	**251**	**78.7**	**102**
Lead	400	120	**13.4**	**4,900**	**593**	**970**
Nickel	150	38	**5.78**	**8.74**	**6.69**	**6.5**
Zinc	2,300	120	**14.3**	**49.7**	**21.9**	**31.1**

Notes:

Exceeds RSL

Exceeds ECO

Bold indicates detections

J - Analyte present, value may or may not be accurate or precise
L - Analyte present, value may be biased low, actual value may be higher
R - Unreliable Result
U - The material was analyzed for, but not detected
MG/KG - Milligrams per kilogram

TABLE 4-2
Soil Sample Analytical Results, Machine Gun Boresight Range - NAS Oceana
NAS Oceana (CTO-WE03)
June 2010

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	OCMGBR-SO05	OCMGBR-SO06	OCMGBR-SO07	OCMGBR-SO08
Sample ID			OCMGBR-SS05-0610	OCMGBR-SS06-0610	OCMGBR-SS07-0610	OCMGBR-SS08-0610
Sample Date			06/18/10	06/18/10	06/18/10	06/18/10
Chemical Name						
Total Metals (MG/KG)						
Antimony	3.1	78	**7.73**	**4.93**	**0.934**	**13.1**
Arsenic	0.39	18	**4.03**	**2.02**	**2.53**	**5.36**
Copper	310	70	**1,100**	**1,830**	**253**	**4,310**
Lead	400	120	**13,500**	**3,500**	**2,750**	**19,500**
Nickel	150	38	**9.67**	**11.7**	**9.67**	**10.6**
Zinc	2,300	120	**195**	**371**	**63**	**524**

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	OCMGBR-SO05	OCMGBR-SO06	OCMGBR-SO07	OCMGBR-SO08
Sample ID			OCMGBR-SB05-0610	OCMGBR-SB06-0610	OCMGBR-SB07-0610	OCMGBR-SB08-0610
Sample Date			06/18/10	06/18/10	06/18/10	06/18/10
Chemical Name						
Total Metals (MG/KG)						
Antimony	3.1	78	**57.1**	**0.588 J**	0.804 U	**0.301 J**
Arsenic	0.39	18	**4.96**	**2.19**	**2.04**	**1.78**
Copper	310	70	**721**	**1,060**	**40.2**	**806**
Lead	400	120	**16,000**	**747**	**286**	**740**
Nickel	150	38	**10.5**	**10.8**	**8.23**	**9.08**
Zinc	2,300	120	**159**	**216**	**24.1**	**281**

Notes:

Exceeds RSL

Exceeds ECO

Bold indicates detections

J - Analyte present, value may or may not be accurate or precise

L - Analyte present, value may be biased low, actual value may b

R - Unreliable Result

U - The material was analyzed for, but not detected

MG/KG - Milligrams per kilogram

TABLE 4-3

Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Surface Soil

Machine Gun Boresight Range

NAS Oceana

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface Soil	7440-36-0	**Antimony**	**9.3E-01**	**1.3E+01**	**MG/KG**	**OCMGBR-SS08-0610**	**6/8**	**0.761 - 1.01**	**1.3E+01**	**N/A**	**3.1E+00 N**	**6.6E-01**	**SSL**	**YES**	**ASL**
	7440-38-2	**Arsenic**	**1.7E+00**	**5.4E+00**	**MG/KG**	**OCMGBR-SS08-0610**	**8/8**	**0.305 - 0.405**	**5.4E+00**	**N/A**	**3.9E-01 C***	**1.3E-03**	**SSL**	**YES**	**ASL**
	7440-50-8	**Copper**	**2.5E+01**	**4.3E+03**	**MG/KG**	**OCMGBR-SS08-0610**	**8/8**	**0.508 - 62.9**	**4.3E+03**	**N/A**	**3.1E+02 N**	**5.1E+01**	**SSL**	**YES**	**ASL**
	7439-92-1	**Lead**	**2.4E+02**	**2.0E+04**	**MG/KG**	**OCMGBR-SS08-0610**	**8/8**	**0.185 - 18.9**	**2.0E+04**	**N/A**	**4.0E+02 NL**	**N/A**		**YES**	**ASL**
	7440-02-0	Nickel	6.6E+00	1.2E+01	MG/KG	OCMGBR-SS06-0610	8/8	0.508 - 0.675	1.2E+01	N/A	1.5E+02 N	4.8E+01	SSL	NO	BSL
	7440-66-6	Zinc	1.8E+01	5.2E+02	MG/KG	OCMGBR-SS08-0610	8/8	1.02 - 1.35	5.2E+02	N/A	2.3E+03 N	6.8E+02	SSL	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May , 2010. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. [Online].
Available: http://epa-prgs.ornl.gov/chemicals/index.shtml. Adjusted (noncarcinogenic RSLs adjusted by dividing by 10) residential soil RSLs.
The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action
Facilities, USEPA, July 14, 1994.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/
To Be Considered

SSL = Protection of groundwater risk-based SSL from RSL Table

C* = N screening level < 100x C screening level, therefore
N screening value/10 used as screening level

N = Noncarcinogenic

N/A = Not available

NL = Noncarcinongenic lead residential soil RSL not adjusted by dividing by 10.

TABLE 4-3a

Risk Ratio Screening for Surface Soil, Maximum Detected Concentration in Surface Soil

Machine Gun Boresight Range

NAS Oceana

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample Location of Maximum Detected Concentration	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)								
Antimony	6 / 8	1.3E+01	OCMGBR-SS08-0610	3.1E+01	1	0.4	NA	Longevity, Blood
Arsenic	8 / 8	5.4E+00	OCMGBR-SS08-0610	3.9E-01	1E-06	NA	1E-05	NA
Copper	**8 / 8**	**4.3E+03**	**OCMGBR-SS08-0610**	**3.1E+03**	**1**	**1.4**	**NA**	**Gastrointestinal**
Cumulative Corresponding Hazard Index[c]						**1.8**		
Cumulative Corresponding Cancer Risk[d]							**1E-05**	
							Total Longevity HI =	0.4
							Total Blood HI =	0.4
							Total Gastrointestinal HI =	1.4

Notes:

a Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

b Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

c Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

d Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Chemical of Potential Concern

mg/kg = micrograms per kilogram

NA = Not available/not applicable.

TABLE 4-3b

Risk Ratio Screening for Surface Soil, 95% UCL Concentration in Surface Soil

Machine Gun Boresight Range

NAS Oceana

Analyte	Detection Frequency	95% UCL		95% UCL Rationale	Screening Level	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)									
Copper	**8 / 8**	**3.2E+03**	**App. Gamma**	**1, 3**	**3.1E+03**	**1.E+00**	**1**	**NA**	**Gastrointestinal**
Cumulative Corresponding Hazard Index[c]							**1**		
Cumulative Corresponding Cancer Risk[d]								**NA**	
								Total Gastrointestinal HI =	1

[a] Corresponding Hazard Index equals 95% UCL divided by the RSL divided by the acceptable risk level.

[b] Corresponding Cancer Risk equals 95% UCL divided by the RSL divided by the acceptable risk level.

[c] Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

[d] Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05,

Constituents selected as COPCs are indicated by shading.

mg/kg = milligrams per kilogram

HI = Hazard Index

ProUCL, Version 4.00.05 used to determine distribution of data and calculate 95% UCL, following recommendations

in users guide (USEPA. May 2010. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).

Options: 95% Approximate Gamma (App. Gamma)

UCL Rationale:

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.

(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.

(3) Test indicates data are gamma distributed.

(4) Distribution tests are inconclusive

TABLE 4-4

Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Subsurface Soil

Machine Gun Boresight Range

NAS Oceana

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Subsurface Soil	**7440-36-0**	**Antimony**	**2.9E-01 J**	**5.7E+01**	**MG/KG**	**OCMGBR-SB05-0610**	**6/7**	**0.766 - 1.05**	**5.7E+01**	**N/A**	**3.1E+00 N**	**6.6E-01**	**SSL**	**YES**	**ASL**
	7440-38-2	**Arsenic**	**1.6E+00**	**5.0E+00**	**MG/KG**	**OCMGBR-SB05-0610**	**8/8**	**0.306 - 0.419**	**5.0E+00**	**N/A**	**3.9E-01 C***	**1.3E-03**	**SSL**	**YES**	**ASL**
	7440-50-8	**Copper**	**4.6E+00 L**	**1.1E+03**	**MG/KG**	**OCMGBR-SB06-0610**	**8/8**	**0.51 - 66.4**	**1.1E+03**	**N/A**	**3.1E+02 N**	**5.1E+01**	**SSL**	**YES**	**ASL**
	7439-92-1	**Lead**	**1.3E+01**	**1.6E+04**	**MG/KG**	**OCMGBR-SB05-0610**	**8/8**	**0.161 - 19.9**	**1.6E+04**	**N/A**	**4.0E+02 NL**	**N/A**		**YES**	**ASL**
	7440-02-0	Nickel	5.8E+00	1.1E+01	MG/KG	OCMGBR-SB06-0610	8/8	0.51 - 0.699	1.1E+01	N/A	1.5E+02 N	4.8E+01	SSL	NO	BSL
	7440-66-6	Zinc	1.4E+01	2.8E+02	MG/KG	OCMGBR-SB08-0610	8/8	1.02 - 1.4	2.8E+02	N/A	2.3E+03 N	6.8E+02	SSL	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May , 2010. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. [Online]. Available: http://epa-prgs.ornl.gov/chemicals/index.shtml. Adjusted (noncarcinogenic RSLs adjusted by dividing by 10) residential soil RSLs. The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

SSL = Protection of groundwater risk-based SSL from RSL Table

C* = N screening level < 100x C screening level, therefore N screening value/10 used as screening level

N = Noncarcinogenic

N/A = Not available

NL = Noncarcinongenic lead residential soil RSL not adjusted by dividing by 10.

J = The analyte was positively identified, the associated numerical value is the approximate concentration of the analyte in the sample.

L = The analyte was positively identified, but the associated numerical value may be biased low.

TABLE 4-4a

Risk Ratio Screening for Subsurface Soil, Maximum Detected Concentration in Subsurface Soil

Machine Gun Boresight Range

NAS Oceana

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample Location of Maximum Detected Concentration	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)								
Antimony	**6 / 7**	**5.7E+01**	**OCMGBR-SB05-0610**	**3.1E+01**	**1**	**1.8**	**NA**	**Longevity, Blood**
Arsenic	8 / 8	5.0E+00	OCMGBR-SB05-0610	3.9E-01	1E-06	NA	1E-05	NA
Copper	8 / 8	1.1E+03	OCMGBR-SB05-0610	3.1E+03	1	0.3	NA	Gastrointestinal
Cumulative Corresponding Hazard Index[c]						**2.2**		
Cumulative Corresponding Cancer Risk[d]							**1E-05**	

Total Longevity HI =	1.8
Total Blood HI =	1.8
Total Gastrointestinal HI =	0.3

Notes:

a Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

b Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

c Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

d Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Chemical of Potential Concern

mg/kg = micrograms per kilogram

NA = Not available/not applicable.

TABLE 4-4b

Risk Ratio Screening for Subsurface Soil, 95% UCL Concentration in Subsurface Soil

Machine Gun Boresight Range

NAS Oceana

Analyte	Detection Frequency	95% UCL		95% UCL Rationale	Screening Level	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)									
Antimony	6 / 7	4.5E+01	95% KM	1, 3	3.1E+01	1	1.4	NA	Longevity, Blood
Cumulative Corresponding Hazard Index[c]							1		
Cumulative Corresponding Cancer Risk[d]								NA	
								Total Longevity HI =	1
								Total Blood HI =	1

[a] Corresponding Hazard Index equals 95% UCL divided by the RSL divided by the acceptable risk level.

[b] Corresponding Cancer Risk equals 95% UCL divided by the RSL divided by the acceptable risk level.

[c] Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

[d] Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05,

Constituents selected as COPCs are indicated by shading.

mg/kg = milligrams per kilogram

HI = Hazard Index

ProUCL, Version 4.00.05 used to determine distribution of data and calculate 95% UCL, following recommendations

in users guide (USEPA. May 2010. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).

'Options: 95% Kaplan-Meier Chebyshev UCL (95% KM)

UCL Rationale:

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.

(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.

(3) Test indicates data are gamma distributed.

(4) Distribution tests are inconclusive

Table 4-5

Ecological Screening Statistics - Machine Gun Boresight Range (Oceana) - Plants and Soil Invertebrates

Naval Air Station Oceana

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL (Norm)	Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Surface Soil															
Inorganics (MG/KG)															
Antimony	0.92 - 0.96	6 / 8	0.93	13.1	OCMGBR-SS08-0610	4.95	4.41	7.91	78.0	0 / 8	0.17	NO	--	--	NO
Arsenic	-- - --	8 / 8	1.69	5.36	OCMGBR-SS08-0610	2.74	1.29	3.60	18.0	0 / 8	0.30	NO	--	--	NO
Copper	-- - --	8 / 8	24.8	4,310	OCMGBR-SS08-0610	1,044	1,457	2,020	70.0	6 / 8	61.6	**YES**	28.9	14.9	**YES**
Lead	-- - --	8 / 8	239	19,500	OCMGBR-SS08-0610	6,642	6,855	11,234	120	8 / 8	163	**YES**	93.6	55.4	**YES**
Nickel	-- - --	8 / 8	6.55	11.7	OCMGBR-SS06-0610	8.81	1.86	10.1	38.0	0 / 8	0.31	NO	--	--	NO
Zinc	-- - --	8 / 8	18.3	524	OCMGBR-SS08-0610	165	188	291	120	3 / 8	4.37	**YES**	2.42	1.38	**YES**
Subsurface Soil															
Inorganics (MG/KG)															
Antimony	0.80 - 0.80	6 / 7	0.29	57.1	OCMGBR-SB05-0610	9.13	21.2	24.7	78.0	0 / 7	0.73	NO	--	--	NO
Arsenic	-- - --	8 / 8	1.62	4.96	OCMGBR-SB05-0610	2.44	1.08	3.16	18.0	0 / 8	0.28	NO	--	--	NO
Copper	-- - --	8 / 8	4.55	1,060	OCMGBR-SB06-0610	383	414	660	70.0	6 / 8	15.1	**YES**	9.43	5.47	**YES**
Lead	-- - --	8 / 8	13.4	16,000	OCMGBR-SB05-0610	3,031	5,464	6,691	120	7 / 8	133	**YES**	55.8	25.3	**YES**
Nickel	-- - --	8 / 8	5.78	10.8	OCMGBR-SB06-0610	8.29	1.85	9.53	38.0	0 / 8	0.28	NO	--	--	NO
Zinc	-- - --	8 / 8	14.3	281	OCMGBR-SB08-0610	99.6	104	170	120	3 / 8	2.34	**YES**	1.41	0.83	NO

1 - Count of detected samples exceeding or equaling Screening Value

Table 4-6
Exceedances - Machine Gun Boresight Range (Oceana) Surface and Subsurface Soil - Plants and Soil Invertebrates
Naval Air Station Oceana

Chemical	Ecological Soil Screening Value	OCMGBR-SO01	OCMGBR-SO02	OCMGBR-SO03	OCMGBR-SO04	OCMGBR-SO05
		OCMGBR-SS01-0610	OCMGBR-SS02-0610	OCMGBR-SS03-0610	OCMGBR-SS04-0610	OCMGBR-SS05-0610
		06/18/10	06/18/10	06/18/10	06/18/10	06/18/10
Inorganics (MG/KG)						
Antimony	78.0	0.924 U	4.66	7.32	0.955 U	7.73
Arsenic	18.0	1.69	2.48	1.87	1.91	4.03
Copper	70.0	24.8	582	187	65.5	1,100
Lead	120	239	9,210	3,770	668	13,500
Nickel	38.0	6.55	7.10	7.27	7.90	9.67
Zinc	120	18.3	87.6	35.3	26.5	195

Chemical	Ecological Soil Screening Value	OCMGBR-SO01	OCMGBR-SO02	OCMGBR-SO03	OCMGBR-SO04	OCMGBR-SO05
		OCMGBR-SB01-0610	OCMGBR-SB02-0610	OCMGBR-SB03-0610	OCMGBR-SB04-0610	OCMGBR-SB05-0610
		06/18/10	06/18/10	06/18/10	06/18/10	06/18/10
Inorganics (MG/KG)						
Antimony	78.0	0.924 R	4.31	0.288 J	0.926 J	57.1
Arsenic	18.0	1.62	2.81	1.84	2.24	4.96
Copper	70.0	4.55 L	251	78.7	102	721
Lead	120	13.4	4,900	593	970	16,000
Nickel	38.0	5.78	8.74	6.69	6.50	10.5
Zinc	120	14.3	49.7	21.9	31.1	159

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections

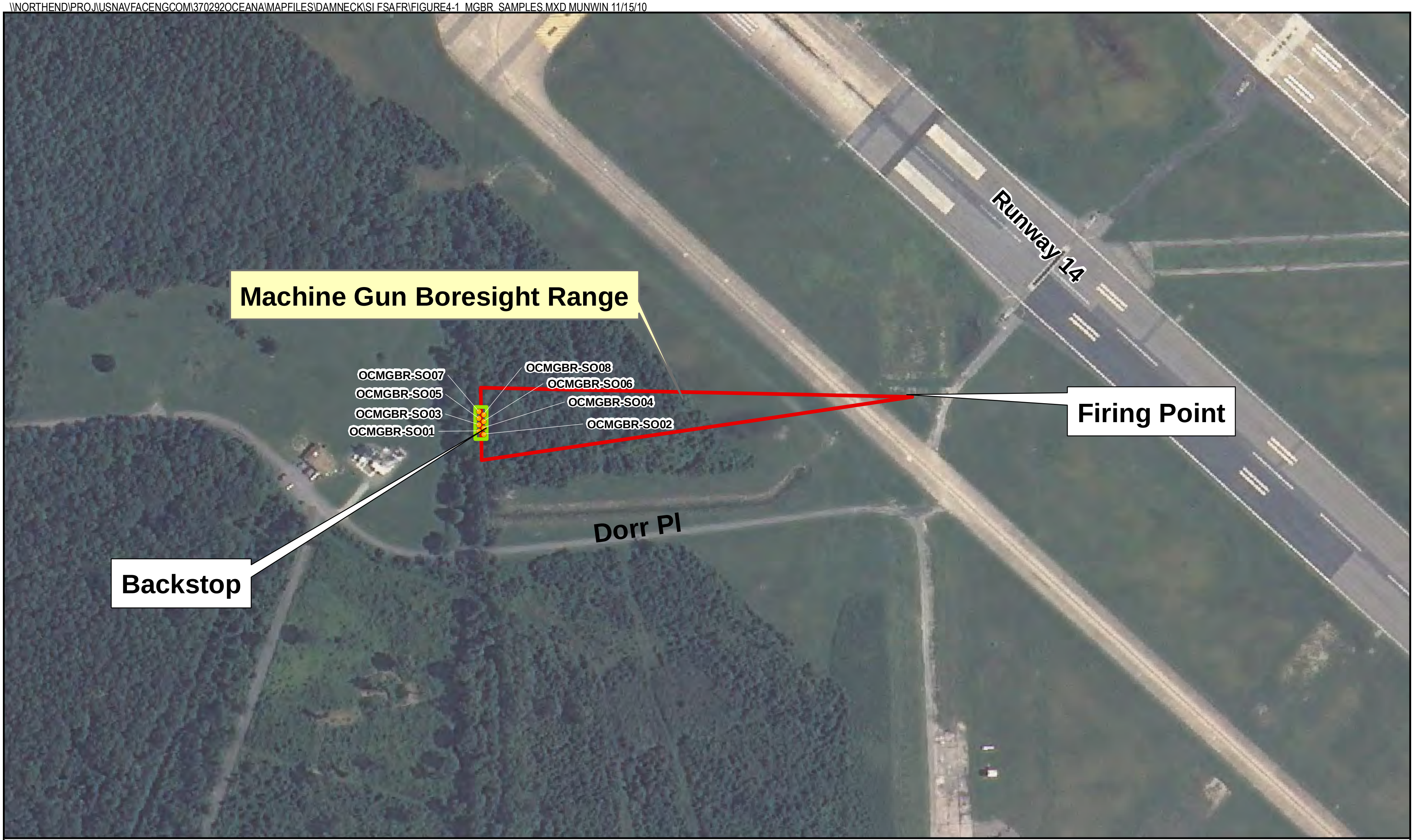
Table 4-6
Exceedances - Machine Gun Boresight Range (Oceana) Surface and Subsurface Soil - Plants and Soil Invertebrates
Naval Air Station Oceana

Chemical	Ecological Soil Screening Value	OCMGBR-SO06	OCMGBR-SO07	OCMGBR-SO08
		OCMGBR-SS06-0610	OCMGBR-SS07-0610	OCMGBR-SS08-0610
		06/18/10	06/18/10	06/18/10
Inorganics (MG/KG)				
Antimony	78.0	4.93	0.934	13.1
Arsenic	18.0	2.02	2.53	5.36
Copper	70.0	1,830	253	4,310
Lead	120	3,500	2,750	19,500
Nickel	38.0	11.7	9.67	10.6
Zinc	120	371	63.0	524

Chemical	Ecological Soil Screening Value	OCMGBR-SO06	OCMGBR-SO07	OCMGBR-SO08
		OCMGBR-SB06-0610	OCMGBR-SB07-0610	OCMGBR-SB08-0610
		06/18/10	06/18/10	06/18/10
Inorganics (MG/KG)				
Antimony	78.0	0.588 J	0.804 U	0.301 J
Arsenic	18.0	2.19	2.04	1.78
Copper	70.0	1,060	40.2	806
Lead	120	747	286	740
Nickel	38.0	10.8	8.23	9.08
Zinc	120	216	24.1	281

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\DAMNECK\SI FSAFR\FIGURE4-1_MGBR_SAMPLES.MXD MUNWIN 11/15/10



Legend
- Soil Sample Location
- MRP Site
- Backstop

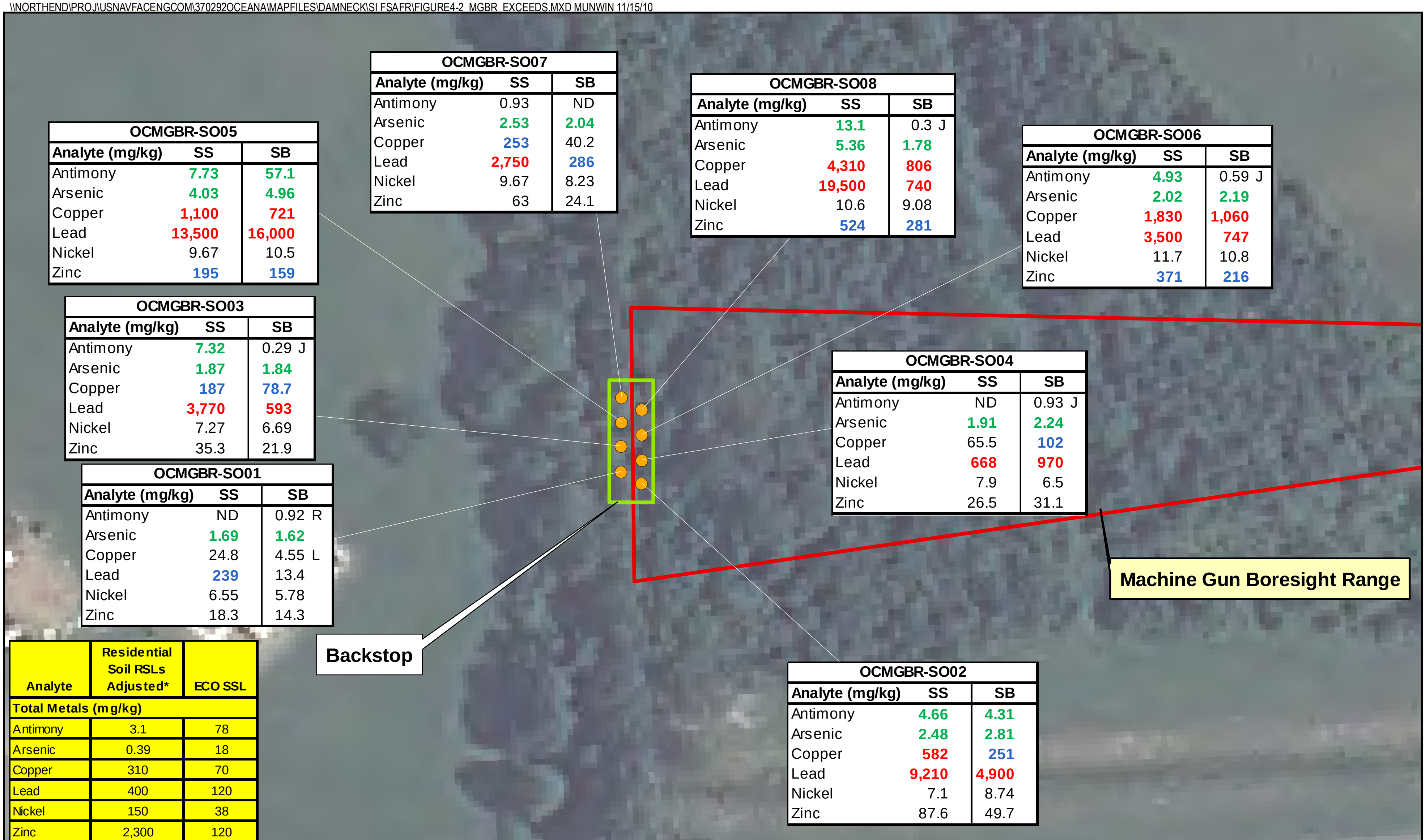
N
W E
S

0 150 300 Feet

Figure 4-1
Machine Gun Boresight Range Sample Locations,
NAS Oceana
Site Inspection of the Former
Small Arms Firing Ranges
Naval Air Station Oceana
Virginia Beach, Virginia

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\DAMNECK\SI FSAFR\FIGURE4-2_MGBR_EXCEEDS.MXD MUNWIN 11/15/10



OCMGBR-SO07

Analyte (mg/kg)	SS	SB
Antimony	0.93	ND
Arsenic	2.53	2.04
Copper	253	40.2
Lead	2,750	286
Nickel	9.67	8.23
Zinc	63	24.1

OCMGBR-SO08

Analyte (mg/kg)	SS	SB
Antimony	13.1	0.3 J
Arsenic	5.36	1.78
Copper	4,310	806
Lead	19,500	740
Nickel	10.6	9.08
Zinc	524	281

OCMGBR-SO05

Analyte (mg/kg)	SS	SB
Antimony	7.73	57.1
Arsenic	4.03	4.96
Copper	1,100	721
Lead	13,500	16,000
Nickel	9.67	10.5
Zinc	195	159

OCMGBR-SO06

Analyte (mg/kg)	SS	SB
Antimony	4.93	0.59 J
Arsenic	2.02	2.19
Copper	1,830	1,060
Lead	3,500	747
Nickel	11.7	10.8
Zinc	371	216

OCMGBR-SO03

Analyte (mg/kg)	SS	SB
Antimony	7.32	0.29 J
Arsenic	1.87	1.84
Copper	187	78.7
Lead	3,770	593
Nickel	7.27	6.69
Zinc	35.3	21.9

OCMGBR-SO04

Analyte (mg/kg)	SS	SB
Antimony	ND	0.93 J
Arsenic	1.91	2.24
Copper	65.5	102
Lead	668	970
Nickel	7.9	6.5
Zinc	26.5	31.1

OCMGBR-SO01

Analyte (mg/kg)	SS	SB
Antimony	ND	0.92 R
Arsenic	1.69	1.62
Copper	24.8	4.55 L
Lead	239	13.4
Nickel	6.55	5.78
Zinc	18.3	14.3

OCMGBR-SO02

Analyte (mg/kg)	SS	SB
Antimony	4.66	4.31
Arsenic	2.48	2.81
Copper	582	251
Lead	9,210	4,900
Nickel	7.1	8.74
Zinc	87.6	49.7

Analyte	Residential Soil RSLs Adjusted*	ECO SSL
Total Metals (mg/kg)		
Antimony	3.1	78
Arsenic	0.39	18
Copper	310	70
Lead	400	120
Nickel	150	38
Zinc	2,300	120

Legend

- Soil Sample Location
- MRP Site
- Backstop

NOTES:

Concentrations shown in green exceed the USEPA residential soil regional screening levels
Concentrations shown in blue exceed the ecological soil screening levels
Concentrations shown in red exceed both the ecological and residential screening levels
J - Analyte present, value may or may not be accurate or precise
L - Analyte present, value may be biased low, actual value may be higher
R - Unreliable Result
ND - Analyte not detected
mg/kg - milligrams per kilogram
SS - Surface soil
SB - Subsurface soil

N W E S

0 40 80 Feet

Figure 4-2
Machine Gun Boresight Range Exceedances,
NAS Oceana
Site Inspection of the Former
Small Arms Firing Ranges
Naval Air Station Oceana
Virginia Beach, Virginia

CH2MHILL

SECTION 5

Dam Neck Annex: Pistol Range North

5.1 Site Background

The former Pistol Range North is located near the southeastern portion of Dam Neck Annex, as shown on **Figure 5-1**. Specifically, the site lies along the east side of Regulus Avenue and just north of the active Drone Launching Area. The site was formerly a small arms shooting range, covering approximately 2 acres. The direction of fire was presumed to be toward the east, in the direction of the Atlantic Ocean (Malcolm Pirnie, 2008). Although the 1950 map shows the general outline and orientation of the former range, no backstop or berm was identified. It is unclear whether the natural topography of nearby dunes served as a backstop during site activities. Based on observations from a site visit conducted by CH2M HILL in July 2009, the eastern portion of the site is currently covered by a parking lot and Regulus Avenue itself. The remaining portion is composed of an undeveloped lowland area covered with dense brush and sand dunes. No evidence of the range or associated structures was observed. The former range lies within a Dune Management Area and is protected pursuant to the Coastal Sand Dune Protection Act, a program administered by the Virginia Marine Resources Commission. There are no wetlands or water bodies on the site.

Ammunition used at the former Pistol Range North was expected to be limited to .22, .38, and .45 caliber rounds for small arms (Malcolm Pirnie, 2008). Potential MC related to small arms ammunition are lead, antimony, arsenic, copper, nickel, and zinc (Malcolm Pirnie, 2008). Based on the nature of the munitions likely to have been used on site, the potential source of contamination is suspected to be within the top 12 inches of the surface.

5.2 Rationale for Investigation

Potential sources of contamination present at the former range are debris related to small arms firing range ammunition. It was concluded that surface soils are the most likely medium to be contaminated based on the use of the range. Because groundwater in this area is not anticipated to be affected, the SI did not evaluate groundwater as a potential route of exposure. There is no surface water or sediment present onsite.

5.3 Field Activities

5.3.1 Visual and Metal Detector Surveys

During the sampling event, the sampling area was visually inspected, as described in Section 3.2. During this inspection, some potential range-related debris was found near location DNPRN-SO17.

A metal detector survey was not conducted at the site because of the densely vegetated and inaccessible areas.

5.3.2 Sample Collection

Discrete surface soil samples were collected from 0-12 inches bgs from 18 locations within the former Pistol Range North area. Two of the originally planned locations (DNPRN-SO02 and DNPRN-SO15) were inadvertently not sampled because of a field investigation error. Even though the samples were not collected, the conclusions derived from the other sample results for this site were not compromised.

The DNPRN-SO17 location was biased towards the area where potential range-related debris was observed (approximately 20 feet to the southwest of the original sampling location for DNPRN-SO17). No other evidence of metal debris was found, so the remaining samples were collected at the locations designated in the UFP-SAP. Sample locations are presented on **Figure 5-1**. Samples were analyzed for lead, antimony, arsenic, copper, nickel, and zinc.

5.4 Release Assessment Decision Analysis

Data for the samples collected during the field investigations were evaluated in accordance with the decision logic presented on **Figure 3-1** and approved by the project team during development of the UFP-SAP (CH2M HILL, 2010). The following subsections describe the steps in the decision process, analytical results, and an evaluation of potential risks at the former Pistol Range North.

Table5-1 presents an exceedance summary of the sample results. **Table 5-2**, presented at the end of this section, contains the validated analytical results of the sample investigation. The results were compared to the following screening values: RSLs for residential soil and Eco-SSLs for plants and soil invertebrates, as described in Section 3.8 and 3.9.

Sections 5.4.1 through 5.4.3 summarize the results associated with each step of the decision analysis.

TABLE 5-1
Pistol Range North Exceedance Summary

Total Number of Samples	Analyte	Units	Max Value	Residential Soil RSL	Number of Residential Soil RSL Exceedances	ECO-SSL	Number of ECO-SSL Exceedances
18	Arsenic	mg/kg	3.76	0.39	18/18	18	0/18

5.4.1 Step 1

Eighteen surface samples were collected at the Pistol Range North during the SI field sampling activities. In Step 1, the sample results were compared to the human health and ecological screening levels. As shown in **Table 5-1**, the arsenic sample results exceeded the RSL screening level at all 18 locations.

On the basis of the arsenic exceedances, the decision analysis followed the path to Step 2.

5.4.2 Step 2

Because of the magnitude of the arsenic exceedances, more-realistic evaluations of the data were undertaken to decide if further action would be necessary. Potential ecological and human health risks were evaluated. The results of these evaluations are discussed as follows. No COPCs were identified in the human health or ecological evaluations, so the decision analysis followed the path to Step 1a.

HHRS Results

The risk-based screening evaluation for surface soil at the Dam Neck Annex Pistol Range North is presented in **Tables 5-3** and **5-3a**. No COPCs were identified for Pistol Range North surface soils.

Surface Soil

Tables 5-3 and **5-3a** present the risk-based screening evaluation for surface soil. One metal, arsenic, was identified as a Step 1 COPC and retained for evaluation in Step 2. Based on Step 2 (risk ratio using maximum detected concentrations), arsenic was eliminated as a COPC. Therefore, no unacceptable human health risks were identified.

HHRS Results Summary

Based on the HHRS evaluation for Dam Neck Annex Pistol Range North, no unacceptable human health risks were identified. Therefore, no further human health risk evaluation of the site is necessary.

Ecological Risk Screening Results

The results of the ecological risk evaluation for Pistol Range North are presented in **Tables 5-4** and **5-5**.

Surface Soil

None of the metals sampled for in Pistol Range North surface soils exceeded ecological soil screening values for plants and soil invertebrates (**Table 5-4**). Therefore, no unacceptable risks exist for these receptors on the site.

Food Web Exposures

Sampled metals with available bird and/or mammal Eco-SSLs were first screened against these values (**Table 5-5**). Zinc was the only chemical that exceeded its Eco-SSL (for birds) based on the maximum detected concentration. However, the magnitude of the maximum HQ was very low (1.10), and there were no exceedances based on the mean or 95 percent UCL soil concentrations. Therefore, no unacceptable risks exist for these receptors on the site.

Ecological Risk Screening Summary

No COPCs were identified for Pistol Range North surface soils, so ecological risks at this site are acceptable and no further action (NFA) is recommended for ecological receptors at this site.

5.4.3 Step 1a

Eighteen soil samples were collected at the site, as shown on **Figure 5-1**. The historical information and spatial distribution of data indicate that the potential source area was sufficiently sampled.

5.5 Summary and Conclusions

Based on the conservative risk screening process, the Pistol Range North site does not pose unacceptable risk to human health or the environment. Therefore, no further investigation or action is recommended for this site.

Table 5-2
Soil Sample Analytical Results
Pistol Range North - Dam Neck Annex
NAS Oceana (CTO-WE03)
June 2010

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	DNPRN-SO01	DNPRN-SO03	DNPRN-SO04	DNPRN-SO05	DNPRN-SO06	DNPRN-SO07
Sample ID			DNPRN-SS01-0610	DNPRN-SS03-0610	DNPRN-SS04-0610	DNPRN-SS05-0610	DNPRN-SS06-0610	DNPRN-SS07-0610
Sample Date			06/16/10	06/16/10	06/16/10	06/16/10	06/16/10	06/16/10
Chemical Name								
Total Metals (MG/KG)								
Arsenic	0.39	18	**0.99**	**3.76**	**0.899**	**1.19**	**1.91**	**0.663**
Copper	310	70	**2.11**	**7.73**	**1.5**	**1.4**	**3.77**	**0.989**
Lead	400	120	**5.11**	**5.55**	**4.98**	3.03 B	**8.91**	**5.37**
Nickel	150	38	**1.16**	**6.76**	**0.955**	**2.54**	**13.4**	**0.969**
Zinc	2,300	120	**8.78**	**45.8**	**3.99**	**6.41**	**50.5**	**3.93**

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	DNPRN-SO08	DNPRN-SO09	DNPRN-SO10	DNPRN-SO11		DNPRN-SO12
Sample ID			DNPRN-SS08-0610	DNPRN-SS09-0610	DNPRN-SS10-0610	DNPRN-SS11-0610	DNPRN-SS11P-0610	DNPRN-SS12-0610
Sample Date			06/16/10	06/16/10	06/16/10	06/16/10	06/16/10	06/16/10
Chemical Name								
Total Metals (MG/KG)								
Arsenic	0.39	18	**1.57**	**0.843**	**0.586**	**0.539**	**0.529**	**0.588**
Copper	310	70	**4.38**	**0.92**	**0.454 J**	**0.725**	**0.649**	**0.356 J**
Lead	400	120	**4.71**	**5.98**	3.53 B	**5.19**	**4.42**	3.46 B
Nickel	150	38	**5.04**	**0.77**	**0.339 J**	**0.474 J**	**0.409 J**	**0.452 J**
Zinc	2,300	120	**25**	**3.64**	**3.64**	1.87 B	1.85 B	2.25 B

Notes:

Exceeds RSL

Exceeds ECO

Bold indicates detections

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

U - The material was analyzed for, but not detected

MG/KG - Milligrams per kilogram

Table 5-2
Soil Sample Analytical Results
Pistol Range North - Dam Neck Annex
NAS Oceana (CTO-WE03)
June 2010

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	DNPRN-SO13	DNPRN-SO14		DNPRN-SO16		DNPRN-SO17
Sample ID			DNPRN-SS13-0610	DNPRN-SS14-0610	DNPRN-SS14P-0610	DNPRN-SS16-0610	DNPRN-SS16P-0610	DNPRN-SS17-0610
Sample Date			06/16/10	06/16/10	06/16/10	06/16/10	06/16/10	06/16/10
Chemical Name								
Total Metals (MG/KG)								
Arsenic	0.39	18	**0.543**	**0.574**	**0.533**	**0.599**	**0.627**	**0.477**
Copper	310	70	**0.304 J**	**0.558**	**0.367 J**	0.501 U	0.517 U	0.612 U
Lead	400	120	2.46 B	**4.61**	**4.35**	3.5 B	3.33 B	1.31 B
Nickel	150	38	**0.37 J**	**0.45 J**	**0.43 J**	**0.361 J**	**0.373 J**	**0.325 J**
Zinc	2,300	120	1.91 B	2.41 B	2.16 B	1.98 B	1.79 B	1.99 B

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	DNPRN-SO18		DNPRN-SO19	DNPRN-SO20
Sample ID			DNPRN-SS18-0610	DNPRN-SS18P-0610	DNPRN-SS19-0610	DNPRN-SS20-0610
Sample Date			06/16/10	06/16/10	06/16/10	06/16/10
Chemical Name						
Total Metals (MG/KG)						
Arsenic	0.39	18	**0.569**	**0.528**	**0.543**	**0.577**
Copper	310	70	**0.296 J**	**0.48 J**	**0.283 J**	**0.332 J**
Lead	400	120	2.05 B	2.26 B	3.54 B	**3.64**
Nickel	150	38	**0.29 J**	**0.302 J**	**0.276 J**	**0.404 J**
Zinc	2,300	120	1.65 B	1.7 B	1.87 B	2.18 B

Notes:

Exceeds RSL

Exceeds ECO

Bold indicates detections

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

U - The material was analyzed for, but not detected

MG/KG - Milligrams per kilogram

TABLE 5-3

Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Surface Soil

Pistol Range North

Dam Neck Annex

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface Soil	**7440-38-2**	**Arsenic**	**4.8E-01**	**3.8E+00**	**MG/KG**	**DNPRN-SS03-0610**	**18/18**	**0.297 - 0.381**	**3.8E+00**	**N/A**	**3.9E-01 C***	**1.3E-03**	**SSL**	**YES**	**ASL**
	7440-50-8	Copper	2.8E-01 J	7.7E+00	MG/KG	DNPRN-SS03-0610	16/18	0.495 - 0.636	7.7E+00	N/A	3.1E+02 N	5.1E+01	SSL	NO	BSL
	7439-92-1	Lead	3.6E+00	8.9E+00	MG/KG	DNPRN-SS06-0610	10/18	0.149 - 0.191	8.9E+00	N/A	4.0E+02 NL	N/A		NO	BSL
	7440-02-0	Nickel	2.8E-01 J	1.3E+01	MG/KG	DNPRN-SS06-0610	18/18	0.495 - 0.636	1.3E+01	N/A	1.5E+02 N	4.8E+01	SSL	NO	BSL
	7440-66-6	Zinc	3.6E+00	5.1E+01	MG/KG	DNPRN-SS06-0610	9/18	0.991 - 1.27	5.1E+01	N/A	2.3E+03 N	6.8E+02	SSL	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May , 2010. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. [Online]. Available: http://epa-prgs.ornl.gov/chemicals/index.shtml. Adjusted (noncarcinogenic RSLs adjusted by dividing by 10) residential soil RSLs.
The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

SSL = Protection of groundwater risk-based SSL from RSL Table

C = Carcinogenic

C* = N screening level < 100x C screening level, therefore N screening value/10 used as screening level

N = Noncarcinogenic

N/A = Not available

NL = Noncarcinongenic lead residential soil RSL not adjusted by dividing by 10.

J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.

TABLE 5-3a

Risk Ratio Screening for Surface Soil, Maximum Detected Concentration in Surface Soil

Pistol Range North

Dam Neck Annex

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample Location of Maximum Detected Concentration	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)								
Arsenic	18 / 18	3.8E+00	DNPRN-SS03-0610	3.9E-01	1E-06	NA	1E-05	NA
Cumulative Corresponding Hazard Index[c]						**0.0**		
Cumulative Corresponding Cancer Risk[d]							**1E-05**	

Notes:

a Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

b Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

c Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

d Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Chemical of Potential Concern

mg/kg = micrograms per kilogram

NA = Not available/not applicable.

Table 5-4

Ecological Screening Statistics - Pistol Range North Surface Soil - Plants and Soil Invertebrates

Fleet Combat Training Center - Dam Neck Annex

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL (Norm)	Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Inorganics (MG/KG)															
Antimony	0.75 - 0.95	0 / 18	--	--	--	0.41	0.031	0.42	78.0	-- / --	0.01	NO	--	--	NO
Arsenic	-- - --	18 / 18	0.48	3.76	DNPRN-SS03-0610	0.97	0.80	1.30	18.0	0 / 18	0.21	NO	--	--	NO
Copper	0.52 - 0.61	16 / 18	0.28	7.73	DNPRN-SS03-0610	1.49	1.96	2.30	70.0	0 / 18	0.11	NO	--	--	NO
Lead	1.31 - 3.54	10 / 18	3.64	8.91	DNPRN-SS06-0610	3.64	2.28	4.58	120	0 / 18	0.07	NO	--	--	NO
Nickel	-- - --	18 / 18	0.28	13.4	DNPRN-SS06-0610	1.96	3.37	3.35	38.0	0 / 18	0.35	NO	--	--	NO
Zinc	1.70 - 2.41	9 / 18	3.64	50.5	DNPRN-SS06-0610	8.93	15.4	15.2	120	0 / 18	0.42	NO	--	--	NO

1 - Count of detected samples exceeding or equaling Screening Value

2 - Shaded cells indicate hazard quotient based on reporting limits

Table 5-5
Screening Statistics - Pistol Range North Surface Soil - Mammal/Bird Eco-SSLs
Fleet Combat Training Center - Dam Neck Annex

Chemical	Range of Non-Detect Values	Frequency of Detection	Maximum Concentration Detected	95% UCL (Norm)	Arithmetic Mean	Mammal Eco-SSL	Frequency of Exceedance	Maximum Hazard Quotient	95% UCL Hazard Quotient	Mean Hazard Quotient	Bird Eco-SSL	Frequency of Exceedance	Maximum Hazard Quotient	95% UCL Hazard Quotient	Mean Hazard Quotient
Inorganics (MG/KG)															
Antimony	0.75 - 0.95	0 / 18	--	0.42	0.41	0.27	-- / --	--[1]	--	--	--	-- / --	--	--	--
Arsenic	-- - --	18 / 18	3.76	1.30	0.97	46.0	0 / 18	0.08	0.03	0.02	43.0	0 / 18	0.09	0.03	0.02
Copper	0.52 - 0.61	16 / 18	7.73	2.30	1.49	49.0	0 / 18	0.16	0.05	0.03	28.0	0 / 18	0.28	0.08	0.05
Lead	1.31 - 3.54	10 / 18	8.91	4.58	3.64	56.0	0 / 18	0.16	0.08	0.07	11.0	0 / 18	0.81	0.42	0.33
Nickel	-- - --	18 / 18	13.4	3.35	1.96	130	0 / 18	0.10	0.03	0.02	210	0 / 18	0.06	0.02	0.01
Zinc	1.70 - 2.41	9 / 18	50.5	15.2	8.93	79.0	0 / 18	0.64	0.19	0.11	46.0	1 / 18	1.10	0.33	0.19

Shaded cells indicate HQ > 1

1 - HQs are not calculated for non-detected chemicals

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\DAMNECK\SI FSAFR\FIGURE5-1_PISTOL_RANGE_NORTH_SAMPLE_LOCATIONS.MXD MUNWIN 11/15/10

Legend

- MRP Site
- Soil Sample (0-12")
- Operational Range Area

N W E S

0 75 150 Feet

Figure 5-1
Pistol Range North Sample Locations
Site Inspection of the Former
Small Arms Firing Ranges
Dam Neck Annex, NAS Oceana
Virginia Beach, Virginia

CH2MHILL

SECTION 6

Dam Neck Annex: Pistol Range South

6.1 Site Background

The former Pistol Range South is located near the southwestern portion of Dam Neck Annex (**Figure 6-1**). Specifically, the site is adjacent to Bullpup Avenue and is identified in archival maps as early as 1942. The former Pistol Range South consisted of a small arms shooting range, covering approximately 1 acre (Malcolm Pirnie, 2008). The direction of fire was southeast, toward a berm that has since been removed from the site. As observed during a site reconnaissance by Malcolm Pirnie in December 2007, and a site visit by CH2M HILL on July 30, 2009, the entire site has been graded and developed as Building 464, a grassy field, and an associated parking lot. The building portion currently occupies approximately 90 percent of the site area. No evidence of the former range or associated structures was observed.

Ammunition used at the former Pistol Range South was expected to be limited to .22, .38, and .45 caliber rounds for small arms. Potential MC associated with these types of ammunition are lead, antimony, arsenic, copper, nickel, and zinc (Malcolm Pirnie, 2008). Based on the nature of the munitions likely to have been used onsite, the potential source of contamination is suspected to be within the top 12 inches of the surface. There are no wetlands or water bodies on the site.

6.2 Rationale for Investigation

Potential sources of contamination present at the former range are debris related to small arms firing range ammunition. Based on the nature of the munitions likely to have been used onsite, the potential source of contamination is suspected to be within the top 12 inches of the surface. Therefore, if a release has occurred, the most likely medium to be affected is surface soil. Because groundwater in this area is not anticipated to be affected, the SI did not evaluate groundwater as a potential route of exposure. There is no surface water or sediment present onsite.

6.3 Field Activities

6.3.1 Visual and Metal Detector Surveys

During the sampling event, the sampling area was visually inspected, as described in Section 3.2. No evidence of spent shell casings and other range-related debris were found at the site.

A metal detector survey also was completed at the site, as described in Section 3.3. No expended casings or shot were identified during the metal detector survey.

6.3.2 Sample Collection

Discrete surface soil samples were collected from 0 to 12 inches bgs from eight locations in the area assumed to be the former backstop at the site. No evidence of metal debris was found, so samples were collected at the locations designated in the UFP-SAP and shown on **Figure 6-1**. Samples collected at three of the locations (shown in blue on **Figure 6-1**) were analyzed by the lab. The samples collected at the other locations (shown in red on **Figure 6-1**) were collected and held by the laboratory in order to reduce laboratory costs because this area is not suspected to have high levels of contamination. If the results associated with the first three samples exceed acceptable levels, the remaining five samples will be analyzed.

6.4 Release Assessment Decision Analysis

Data for the samples collected during the field investigations were evaluated in accordance with the decision logic presented on **Figure 3-1** and approved by the project team during development of the UFP-SAP (CH2M HILL, 2010). The following subsections describe the steps in the decision process, analytical results, and an evaluation of potential risks at the former Pistol Range South site.

Table 6-1 presents an exceedance summary of the sample results. **Table 6-2**, presented at the end of this section, contains the validated analytical results of the sample investigation. The results were compared to the following screening values: RSLs for residential soil and Eco-SSLs for plants and soil invertebrates, as described in Section 3.8 and 3.9.

Sections 6.4.1 through 6.4.3 summarize the results associated with each step of the decision analysis.

TABLE 6-1
Pistol Range South Exceedance Summary

Total Number of Samples	Analyte	Units	Max Value	Residential Soil RSL	Number of Residential Soil RSL Exceedances	ECO-SSL	Number of ECO-SSL Exceedances
3	Arsenic	mg/kg	2.37	0.39	3/3	18	0/3

6.4.1 Step 1

Eight surface samples were collected at the Pistol Range South during the field sampling activities. Three samples were analyzed by the lab. The remaining samples are currently on hold at the laboratory. In Step 1, the sample results were compared to the human health and ecological screening levels. As shown in **Table 6-1**, arsenic sample results exceeded the human health screening levels at all three locations.

6.4.2 Step 2

Because of the magnitude of arsenic exceedances, more-realistic evaluations of the data were undertaken to decide if further action would be necessary. Potential ecological and human health risks were evaluated. The results of these evaluations are discussed as follows. No COPCs were identified in the human health or ecological evaluations, so the decision analysis followed the path to Step 1a.

HHRS Results

The risk-based screening evaluation for surface soil at the Dam Neck Annex Pistol Range South is presented in **Tables 6-3** and **6-3a**.

Surface Soil

Tables 6-3 and **6-3a** present the risk-based screening evaluation for surface soil. Arsenic was identified as a Step 1 COPC and retained for evaluation in Step 2. Based on Step 2 (risk ratio using maximum detected concentrations), arsenic was eliminated as a COPC. Therefore, exposure to the surface soil at the site does not pose an unacceptable human health risk.

HHRS Results Summary

Based on the HHRS evaluation for Dam Neck Annex Pistol Range South, no unacceptable human health risks were identified. Therefore, no further human health evaluation of the site is necessary.

Ecological Risk Screening Results

The results of the ecological risk evaluation for the Pistol Range South are presented in **Table 6-4**.

Surface Soil

None of the metals sampled for in Pistol Range South surface soils exceeded ecological soil screening values for plants and soil invertebrates (**Table 6-4**), so no unacceptable risks exist for these receptors on the site.

Ecological Risk Screening Summary

No COPCs were identified for Pistol Range South surface soils, so ecological risks at this site are acceptable and NFA is recommended for ecological receptors at this site.

6.4.3 Step 1a

As planned, eight soil samples were collected at the site (**Figure 6-1**) and three sample were analyzed at the laboratory. The historical information and spatial distribution of data indicate that the potential source area was sufficiently sampled.

6.5 Summary and Conclusions

Based on the conservative risk screening process, the Pistol Range South site does not pose unacceptable risk to human health or the environment. Therefore, no further investigation or action is recommended for this site.

Table 6-2
Soil Sample Analytical Results
Pistol Range South - Dam Neck Annex
NAS Oceana (CTO-WE03)
June 2010

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	DNPRS-SO01	DNPRS-SO02	DNPRS-SO03
Sample ID			DNPRS-SS01-0610	DNPRS-SS02-0610	DNPRS-SS03-0610
Sample Date			06/14/10	06/14/10	06/14/10
Chemical Name					
Total Metals (MG/KG)					
Arsenic	0.39	18	**1.94**	**1.87**	**2.37**
Copper	310	70	**6.92**	**10.2**	**12.4**
Lead	400	120	**13.5**	**14.8**	**23.1**
Nickel	150	38	**9.74**	**9.35**	**3.4**
Zinc	2,300	120	**21.8**	**21.6**	**26.4**

Notes:

Exceeds RSL

Exceeds ECO

Bold indicates detections

MG/KG - Milligrams per kilogram

TABLE 6-3

Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Surface Soil

Pistol Range South

Dam Neck Annex

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface Soil	**7440-38-2**	**Arsenic**	**1.9E+00**	**2.4E+00**	**MG/KG**	**DNPRS-SS03-0610**	**3/3**	**0.349 - 0.373**	**2.4E+00**	**N/A**	**3.9E-01 C***	**1.3E-03**	**SSL**	**YES**	**ASL**
	7440-50-8	Copper	6.9E+00	1.2E+01	MG/KG	DNPRS-SS03-0610	3/3	0.582 - 0.622	1.2E+01	N/A	3.1E+02 N	5.1E+01	SSL	NO	BSL
	7439-92-1	Lead	1.4E+01	2.3E+01	MG/KG	DNPRS-SS03-0610	3/3	0.175 - 0.186	2.3E+01	N/A	4.0E+02 NL	N/A		NO	BSL
	7440-02-0	Nickel	3.4E+00	9.7E+00	MG/KG	DNPRS-SS01-0610	3/3	0.582 - 0.622	9.7E+00	N/A	1.5E+02 N	4.8E+01	SSL	NO	BSL
	7440-66-6	Zinc	2.2E+01	2.6E+01	MG/KG	DNPRS-SS03-0610	3/3	1.16 - 1.24	2.6E+01	N/A	2.3E+03 N	6.8E+02	SSL	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May , 2010. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. [Online].
Available: http://epa-prgs.ornl.gov/chemicals/index.shtml. Adjusted (noncarcinogenic RSLs adjusted by dividing by 10) residential soil RSLs.
The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

SSL = Protection of groundwater risk-based SSL from RSL Table

C = Carcinogenic

C* = N screening level < 100x C screening level, therefore N screening value/10 used as screening level

N = Noncarcinogenic

N/A = Not available

NL = Noncarcinongenic lead residential soil RSL not adjusted by dividing by 10.

Generated by: Roni Warren/WDC Checked by: Debbie Stannard/WDC

TABLE 6-3a
Risk Ratio Screening for Surface Soil, Maximum Detected Concentration in Surface Soil
Pistol Range South
Dam Neck Annex

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample Location of Maximum Detected Concentration	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)								
Arsenic	3 / 3	2.4E+00	DNPRS-SS03-0610	3.9E-01	1E-06	NA	6E-06	NA
Cumulative Corresponding Hazard Index[c]						**0.0**		
Cumulative Corresponding Cancer Risk[d]							**6E-06**	

Notes:
a Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.
b Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.
c Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.
d Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.
Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.
Constituents selected as COPCs are indicated by shading.
COPC = Chemical of Potential Concern
mg/kg = micrograms per kilogram
NA = Not available/not applicable.

Table 6-4

Ecological Screening Statistics - Pistol Range South Surface Soil - Plants and Soil Invertebrates

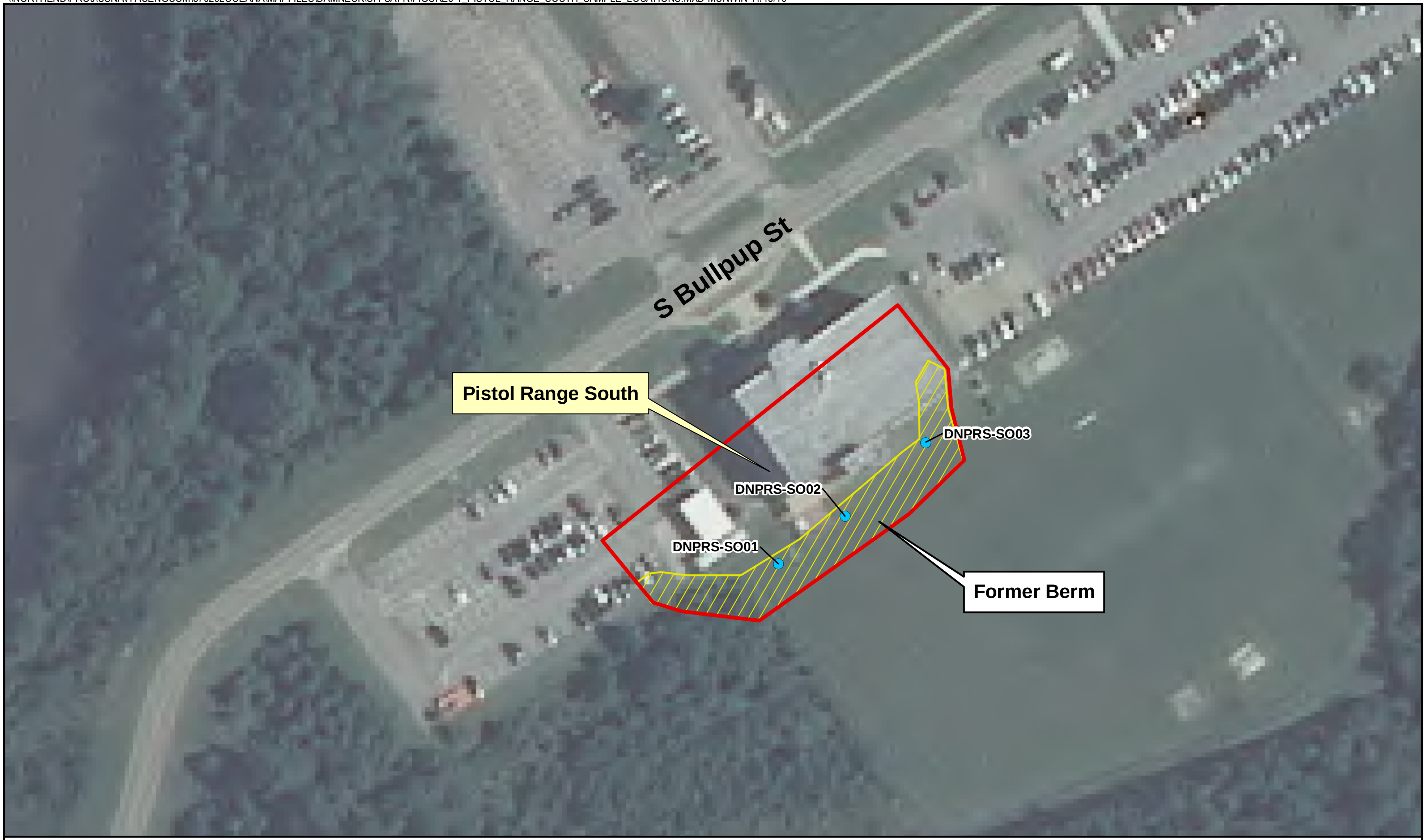
Fleet Combat Training Center - Dam Neck Annex

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL (Norm)	Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Inorganics (MG/KG)															
Antimony	0.87 - 0.93	0 / 3	--	--	--	0.45	0.015	0.48	78.0	-- / --	0.01	NO	--	--	NO
Arsenic	-- - --	3 / 3	1.87	2.37	DNPRS-SS03-0610	2.06	0.27	2.52	18.0	0 / 3	0.13	NO	--	--	NO
Copper	-- - --	3 / 3	6.92	12.4	DNPRS-SS03-0610	9.84	2.76	14.5	70.0	0 / 3	0.18	NO	--	--	NO
Lead	-- - --	3 / 3	13.5	23.1	DNPRS-SS03-0610	17.1	5.21	25.9	120	0 / 3	0.19	NO	--	--	NO
Nickel	-- - --	3 / 3	3.40	9.74	DNPRS-SS01-0610	7.50	3.55	13.5	38.0	0 / 3	0.26	NO	--	--	NO
Zinc	-- - --	3 / 3	21.6	26.4	DNPRS-SS03-0610	23.3	2.72	27.8	120	0 / 3	0.22	NO	--	--	NO

1 - Count of detected samples exceeding or equaling Screening Value

2 - Shaded cells indicate hazard quotient based on reporting limits

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\DAMNECK\SI FSAFR\FIGURE6-1_PISTOL_RANGE_SOUTH_SAMPLE_LOCATIONS.MXD MUNWIN 11/15/10



Legend

MRP Site

Soil Sample (0-12") sent to lab

N
W E
S

0 50 100 Feet

Figure 6-1
Pistol Range South Sample Locations
Site Inspection of the Former
Small Arms Firing Ranges
Dam Neck Annex, NAS Oceana
Virginia Beach, Virginia

CH2MHILL

SECTION 7

Dam Neck Annex: Rifle Range

7.1 Site Background

The former Rifle Range is located on the southwestern portion of Dam Neck Annex, east of Regulus Avenue, as shown on **Figure 7-1**. The northern portion of the site is occupied by the active Drone Launching Area and is identified in an archival map from 1950. The site was formerly a practice target range, measuring 600 feet wide by 1,500 feet long. The direction of fire was presumed to be east, toward the Atlantic Ocean (Malcolm Pirnie, 2008). Portions of the Rifle Range are overlapped by the active Drone Launching Area to the east and another MRP site (Moving Target/Mortar Range, North) to the north. The remaining portion of the Rifle Range is covered under the SI and is approximately 6 acres. As observed during the site reconnaissance by Malcolm Pirnie in December 2007 (Malcolm-Pirnie, 2008) and the CH2M HILL site visit on July 30, 2009, the southern portion of the site has been developed as a parking lot. The remaining portion of the site is composed primarily of undeveloped forest, with the extreme eastern portion of the site encroaching on sand dunes/ beach habitat. No evidence of the former range or associated structures was observed by Malcolm Pirnie. There are no wetlands or water bodies on the site. Additionally, the former range occupies parts of all three natural resource management units represented at Dam Neck Annex: urban, natural areas, and beaches and dunes, as defined by the Coastal Sand Dune Protection Act. The protection program is administered by the Virginia Marine Resources Commission.

Ammunition used at the former Rifle Range is expected to be .22, .30, .45, and .30 caliber rounds, as well as 5.56- and 7.62-mm rounds for small arms. Potential MC associated with these types of ammunition are lead, antimony, arsenic, copper, nickel, and zinc (Malcolm Pirnie, 2008). Although no such features were observed at the site, expended small arms rounds typically would be contained by a downrange berm or backstop. Based on the nature of the munitions likely to have been used on site, the potential source of contamination is suspected to be within the top 12 inches of the surface.

7.2 Rationale for Investigation

Potential sources of contamination present at the former range are debris related to small arms firing range ammunition. It was concluded that surface and subsurface soils are the most likely medium to be contaminated based on the use of the range. Because groundwater in this area is not anticipated to be affected, the SI did not evaluate groundwater as a potential route of exposure. There is no surface water or sediment present onsite.

7.3 Field Activities

7.3.1 Visual and Metal Detector Surveys

During the sampling event, the sampling area was visually inspected, as described in Section 3.2. No evidence of spent shell casings and other range-related debris were found at the site.

A metal detector survey was also completed at the site, as described in Section 3.3. No expended casings or shot were identified during the metal detector survey.

7.3.2 Sample Collection

Discrete surface soil samples were collected from 0 to 12 inches bgs at 22 locations within the former Rifle Range area. No evidence of metal debris was found, so samples were collected at the locations designated in the UFP-SAP and as shown on **Figure 7-1**. Samples were analyzed for lead, antimony, arsenic, copper, nickel, and zinc.

7.4 Release Assessment Decision Analysis

Data for the samples collected during the field investigations were evaluated in accordance with the decision logic presented on **Figure 3-1** and approved by the project team during development of the UFP-SAP (CH2M HILL, 2010). The following subsections describe the steps in the decision process, analytical results, and an evaluation of potential risks at the Rifle Range site.

Table 7-1 presents an exceedance summary of the sample results. **Table 7-2**, presented at the end of this section, contains the validated analytical results of the sample investigation. The results were compared to the following screening values: RSLs for residential soil and Eco-SSLs for plants and soil invertebrates, as described in Section 3.8 and 3.9.

Sections 7.4.1 through 7.4.3 summarize the results associated with each step of the decision analysis.

TABLE 7-1
Rifle Range Exceedance Summary

Total Number of Samples	Analyte	Units	Max Value	Residential Soil RSL	Number of Residential Soil RSL Exceedances	ECO-SSL	Number of ECO-SSL Exceedances
22	Arsenic	mg/kg	6.86	0.39	22/22	18	0/22
	Lead	mg/kg	807	400	2/22	120	2/22

7.4.1 Step 1

Twenty-two surface soil samples were collected at the Rifle Range during the field sampling activities. In Step 1, the sample results were compared to the human health and ecological screening levels. As shown in **Table 7-1**, sample results exceeded the screening levels at all locations.

On the basis of these exceedances, the decision analysis followed the path to Step 2.

7.4.2 Step 2

Because of the magnitude of arsenic and lead exceedances, more-realistic evaluations of the data were undertaken to decide if further action would be necessary. Potential ecological and human health risks were evaluated. The results of these evaluations are discussed as follows. No COPCs were identified in the human health or ecological evaluations, so the decision analysis followed the path to Step 1a.

HHRS Results

The risk-based screening evaluation for surface soil at the Dam Neck Annex Rifle Range is presented in **Tables 7-3** and **7-3a**.

Surface Soil

Tables 7-3 and **7-3a** present the risk-based screening evaluation for surface soil. Arsenic was identified as a Step 1 COPC and retained for evaluation in Step 2. Based on Step 2 (risk ratio using maximum detected concentrations), arsenic was eliminated as a COPC. Therefore, exposure to surface soil at the site is not expected to result in any unacceptable human health risks.

Although the maximum detected concentration of lead exceeded the screening value, the average lead concentration did not. Therefore, surface soil does not pose an unacceptable human health risk.

HHRS Summary

Based on the HHRS evaluation for Dam Neck Annex Rifle Range, no unacceptable human health risks were identified. Therefore, based on human health risks, no further evaluation of the site is necessary.

Ecological Risk Screening Results

The results of the ecological risk evaluation for the Rifle Range are presented in **Tables 7-4 through 7-12**.

Surface Soil

Lead was the only chemical that exceeded ecological soil screening values for plants and soil invertebrates, based on maximum detected concentrations (**Table 7-4**). Therefore, lead was identified as an initial COPC and was evaluated using more-realistic assumptions, as follows:

- Lead exceeded screening values in just 2 of 22 samples (**Table 7-5**). Both of these samples (SO-03 and SO-06) occurred directly adjacent to the site fence line and Regulus Avenue in the cleared (grass) area, where habitat quality is limited. These exceedances represent a spatially limited area (less than about 0.25 acre).
- The mean HQ for lead (0.59) was less than 1.

Based on the more-detailed analysis, no refined COPCs were identified, so there are no unacceptable ecological risks for these receptors on the site.

Food Web Exposures

Sampled metals with available bird and/or mammal Eco-SSLs were first screened against these values (**Table 7-6**). Antimony, copper, lead, and zinc exceeded Eco-SSLs, based on the maximum detected concentration. However, the magnitude of the maximum HQ for copper (1.34) and zinc (1.34) was very low, and there were no exceedances based on the mean or 95% UCL soil concentrations for these two metals. Also, antimony was detected in only 1 of 21 samples (at SO-06, where habitat of limited quality exists [see the previous subsection]). Lead exceeded both the bird and mammal Eco-SSLs based on the maximum, mean, and 95% UCL concentrations. Therefore, site-specific food web modeling was conducted only for lead using the following receptor species:

- American robin (*Turdus migratorius*) - terrestrial avian invertivore/omnivore
- Meadow vole (*Microtus pennsylvanicus*) - terrestrial mammalian herbivore
- Mourning dove (*Zenaida macroura*) - terrestrial avian herbivore
- Red fox (*Vulpes vulpes*) - terrestrial mammalian carnivore
- Red-tailed hawk (*Buteo jamaicensis*) - terrestrial avian carnivore
- Short-tailed shrew (*Blarina brevicauda*) - terrestrial mammalian invertivore

The results of the site-specific food web modeling are contained in **Tables 7-7 through 7-12**. NOAEL-based HQs using maximum surface soil concentrations and conservative exposure assumptions exceeded 1 for all six of these receptors. However, NOAEL-based HQs were less than 1 for all receptors when mean surface soil concentrations and more-realistic exposure assumptions were used. Based upon the realistic analysis, no COPCs were identified, so no unacceptable ecological risks exist on the site.

Ecological Risk Screening Summary

No COPCs were identified for Rifle Range surface soils. Therefore, ecological risks at this site are acceptable and NFA is recommended for ecological receptors at this site.

7.4.3 Step 1a

As planned, 22 soil samples were collected at the site (**Figure 7-1**). The historical information and spatial distribution of data indicate that the potential source area was sufficiently sampled.

7.5 Summary and Conclusions

Based on the conservative risk screening process, the Rifle Range site does not pose unacceptable risk to human health or the environment. Therefore, no further investigation or action is recommended for this site.

Table 7-2
Soil Sample Analytical Results
Rifle Range - Dam Neck Annex
NAS Oceana (WE-03)
June 2010

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	DNRR-SO01		DNRR-SO02		DNRR-SO03		DNRR-SO04
Sample ID			DNRR-SS01-0610	DNRR-SS01P-0610	DNRR-SS02-0610	DNRR-SS02P-0610	DNRR-SS03-0610	DNRR-SS03P-0610	DNRR-SS04-0610
Sample Date			06/15/10	06/15/10	06/15/10	06/15/10	06/15/10	06/15/10	06/15/10
Total Metals (MG/KG)									
Antimony	3.1	78	0.795 U	0.874 U	0.791 U	0.869 U	0.803 U	0.888 U	0.811 U
Arsenic	0.39	18	**1.88**	**1.99**	**1.9**	**1.79**	**2.52**	**1.67**	**2.58**
Copper	310	70	**18.8**	**18.3**	**15.3**	**14.6**	**34.6**	**17.7**	**7.81**
Lead	400	120	**27.2**	**26.3**	**40.3**	**39.2**	**443**	**247**	**19.9**
Nickel	150	38	**12.7**	**11.6**	**4.92**	**4.18**	**17.8**	**5.09**	**3.79**
Zinc	2,300	120	**29.8**	**29.2**	**27.8**	**27.5**	**61.8**	**22.8**	**17.1**

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	DNRR-SO04	DNRR-SO05		DNRR-SO06	DNRR-SO07	DNRR-SO08	DNRR-SO09
Sample ID			DNRR-SS04P-0610	DNRR-SS05-0610	DNRR-SS05P-0610	DNRR-SS06-0610	DNRR-SS07-0610	DNRR-SS08-0610	DNRR-SS09-0610
Sample Date			06/15/10	06/15/10	06/15/10	06/15/10	06/16/10	06/16/10	06/16/10
Total Metals (MG/KG)									
Antimony	3.1	78	0.796 U	0.865 U	0.926 U	**2.19 L**	1.2 U	1.19 R	1.13 U
Arsenic	0.39	18	**1.9**	**2.42**	**2.24**	**2.47**	**2.41**	**1.88**	**1.8**
Copper	310	70	**2.82**	**9.52**	**9.52**	**9.96**	**9**	**6.73**	**2.41**
Lead	400	120	**19.1**	**24.3**	**25.6**	**807**	**28.4**	**22.6**	**14.8**
Nickel	150	38	**3.41**	**4.98**	**4.27**	**3.74**	**6.01**	**4.78**	**2.99**
Zinc	2,300	120	**10.4**	**15.1**	**15.4**	**16.3**	**16**	**15.4 K**	**8.7**

Notes:

Exceeds RSL

Exceeds ECO

Bold indicates detections

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

K - Analyte present, value may be biased high, actual value may be lower

L - Analyte present, value may be biased low, actual value may be higher

R - Unreliable Result

U - The material was analyzed for, but not detected

MG/KG - Milligrams per kilogram

Table 7-2
Soil Sample Analytical Results
Rifle Range - Dam Neck Annex
NAS Oceana (WE-03)
June 2010

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	DNRR-SO10	DNRR-SO11	DNRR-SO12	DNRR-SO13	DNRR-SO14	DNRR-SO15	
Sample ID			DNRR-SS10-0610	DNRR-SS11-0610	DNRR-SS12-0610	DNRR-SS13-0610	DNRR-SS14-0610	DNRR-SS15-0610	DNRR-SS15P-0610
Sample Date			06/16/10	06/16/10	06/15/10	06/15/10	06/15/10	06/15/10	06/15/10
Total Metals (MG/KG)									
Antimony	3.1	78	1.14 U	0.849 U	0.846 U	0.879 U	0.906 U	0.862 U	0.904 U
Arsenic	0.39	18	**6.86**	**1.04**	**1.81**	**1.15**	**1.75**	**1.23**	**1.47**
Copper	310	70	**10.5**	**2.07**	**4.11**	**4.92**	**2.82**	**2.46**	**2.45**
Lead	400	120	**32.4**	**10.1**	**11.8**	**7.5**	**9.62**	**6.89**	**9.95**
Nickel	150	38	**1.92**	**0.756**	0.931 B	**2.09**	**2.78**	**2.65**	**2.54**
Zinc	2,300	120	**6.6**	**2.75**	**4.42**	**7.11**	**7.48**	**6.11**	**6.1**

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	DNRR-SO16	DNRR-SO17	DNRR-SO18	DNRR-SO19	DNRR-SO20	DNRR-SO21	DNRR-SO22
Sample ID			DNRR-SS16-0610	DNRR-SS17-0610	DNRR-SS18-0610	DNRR-SS19-0610	DNRR-SS20-0610	DNRR-SS21-0610	DNRR-SS22-0610
Sample Date			06/15/10	06/15/10	06/15/10	06/15/10	06/15/10	06/15/10	06/15/10
Total Metals (MG/KG)									
Antimony	3.1	78	0.905 U	0.973 U	0.967 U	0.752 U	0.842 U	0.813 U	0.93 U
Arsenic	0.39	18	**1.95**	**1.19**	**0.453**	**0.527**	**0.449**	**0.534**	**0.499**
Copper	310	70	**37.5**	**4.88**	**2.08**	**0.794**	**0.684**	**0.617**	**0.551 J**
Lead	400	120	**8.34**	**8.79**	**5.24**	**4.6**	**5.25**	**5.62**	**5.05**
Nickel	150	38	**2.94**	**2.29**	0.586 B	0.58 B	0.33 B	0.276 B	0.62 U
Zinc	2,300	120	**10.8**	**11.8**	**4.22**	2.03 B	1.64 B	2.06 B	1.7 B

Notes:

Exceeds RSL

Exceeds ECO

Bold indicates detections

B - Analyte not detected above the level reported in blanks
J - Analyte present, value may or may not be accurate or precise
K - Analyte present, value may be biased high, actual value may be lower
L - Analyte present, value may be biased low, actual value may be higher
R - Unreliable Result
U - The material was analyzed for, but not detected
MG/KG - Milligrams per kilogram

TABLE 7-3

Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Surface Soil

Rifle Range

Dam Neck Annex

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface Soil	7440-36-0	Antimony	2.2E+00 L	2.2E+00 L	MG/KG	DNRR-SS06-0610	1/21	0.752 - 1.2	2.2E+00	N/A	3.1E+00 N	6.6E-01	SSL	NO	BSL
	7440-38-2	**Arsenic**	**4.5E-01**	**6.9E+00**	**MG/KG**	**DNRR-SS10-0610**	22/22	0.301 - 0.482	**6.9E+00**	**N/A**	**3.9E-01 C***	**1.3E-03**	**SSL**	**YES**	**ASL**
	7440-50-8	Copper	5.5E-01 J	3.8E+01	MG/KG	DNRR-SS16-0610	22/22	0.501 - 0.803	3.8E+01	N/A	3.1E+02 N	5.1E+01	SSL	NO	BSL
	7439-92-1	Lead [6]	4.6E+00	8.1E+02	MG/KG	DNRR-SS06-0610	22/22	0.15 - 0.938	8.1E+02	N/A	4.0E+02 NL	N/A		YES	ASL
	7440-02-0	Nickel	7.6E-01	1.8E+01	MG/KG	DNRR-SS03-0610	16/22	0.501 - 0.803	1.8E+01	N/A	1.5E+02 N	4.8E+01	SSL	NO	BSL
	7440-66-6	Zinc	2.8E+00	6.2E+01	MG/KG	DNRR-SS03-0610	18/22	1 - 1.61	6.2E+01	N/A	2.3E+03 N	6.8E+02	SSL	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May , 2010. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. [Online].
Available: http://epa-prgs.ornl.gov/chemicals/index.shtml. Adjusted (noncarcinogenic RSLs adjusted by dividing by 10) residential soil RSLs.
The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action
Facilities, USEPA, July 14, 1994.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

[6] Lead evaluated differently from other constituents if identifed as a COPC in first step. Average concentration of lead, the value used in the lead IEUBK model, is calculated, and if below screening level, lead not considered a COPC. The average concentration of lead is 70.6 mg/kg, which is below the screening level of 400 mg/kg. Therefore, lead not considered a COPC.

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/
To Be Considered

SSL = Protection of groundwater risk-based SSL from RSL Table

C* = N screening level < 100x C screening level, therefore
N screening value/10 used as screening level

N = Noncarcinogenic

N/A = Not available

NL = Noncarcinongenic lead residential soil RSL not adjusted by dividing by 10.

J = The analyte was positively identified, the associated numerical value is the
approximate concentration of the analyte in the sample.

L = The analyte was positively identified, but the associated numerical value may
be biased low.

TABLE 7-3a
Risk Ratio Screening for Surface Soil, Maximum Detected Concentration in Surface Soil
Rifle Range
Dam Neck Annex

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample Location of Maximum Detected Concentration	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)								
Arsenic	22 / 22	6.9E+00	DNRR-SS10-0610	3.9E-01	1E-06	NA	2E-05	NA
Cumulative Corresponding Hazard Index[c]						**0.0**		
Cumulative Corresponding Cancer Risk[d]							**2E-05**	

Notes:
a Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.
b Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.
c Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.
d Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.
Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.
Constituents selected as COPCs are indicated by shading.
COPC = Chemical of Potential Concern
mg/kg = micrograms per kilogram
NA = Not available/not applicable.

Table 7-4

Ecological Screening Statistics - Rifle Range Surface Soil - Plants and Soil Invertebrates

Fleet Combat Training Center - Dam Neck Annex

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL (Norm)	Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Inorganics (MG/KG)															
Antimony	0.75 - 1.20	1 / 21	2.19	2.19	DNRR-SS06-0610	0.54	0.38	0.69	78.0	0 / 21	0.03	NO	--	--	NO
Arsenic	-- - --	22 / 22	0.45	6.86	DNRR-SS10-0610	1.80	1.35	2.30	18.0	0 / 22	0.38	NO	--	--	NO
Copper	-- - --	22 / 22	0.55	37.5	DNRR-SS16-0610	8.55	10.2	12.3	70.0	0 / 22	0.54	NO	--	--	NO
Lead	-- - --	22 / 22	4.60	807	DNRR-SS06-0610	70.6	188	140	120	2 / 22	6.73	**YES**	1.16	0.59	NO
Nickel	0.28 - 0.93	16 / 22	0.76	17.8	DNRR-SS03-0610	3.58	4.25	5.14	38.0	0 / 22	0.47	NO	--	--	NO
Zinc	1.64 - 2.06	18 / 22	2.75	61.8	DNRR-SS03-0610	12.4	13.7	17.4	120	0 / 22	0.52	NO	--	--	NO

1 - Count of detected samples exceeding or equaling Screening Value

Table 7-5
Exceedances - Rifle Range Surface Soil - Plants and Soil Invertebrates
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Soil Screening Value	DNRR-SO01		DNRR-SO02		DNRR-SO03	
		DNRR-SS01-0610	DNRR-SS01P-0610	DNRR-SS02-0610	DNRR-SS02P-0610	DNRR-SS03-0610	DNRR-SS03P-0610
		06/15/10	06/15/10	06/15/10	06/15/10	06/15/10	06/15/10
Inorganics (MG/KG)							
Antimony	78.0	0.795 U	0.874 U	0.791 U	0.869 U	0.803 U	0.888 U
Arsenic	18.0	1.88	1.99	1.90	1.79	2.52	1.67
Copper	70.0	18.8	18.3	15.3	14.6	34.6	17.7
Lead	120	27.2	26.3	40.3	39.2	443	247
Nickel	38.0	12.7	11.6	4.92	4.18	17.8	5.09
Zinc	120	29.8	29.2	27.8	27.5	61.8	22.8

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections

Table 7-5
Exceedances - Rifle Range Surface Soil - Plants and Soil Invertebrates
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Soil Screening Value	DNRR-SO04		DNRR-SO05		DNRR-SO06	DNRR-SO07
		DNRR-SS04-0610	DNRR-SS04P-0610	DNRR-SS05-0610	DNRR-SS05P-0610	DNRR-SS06-0610	DNRR-SS07-0610
		06/15/10	06/15/10	06/15/10	06/15/10	06/15/10	06/16/10
Inorganics (MG/KG)							
Antimony	78.0	0.811 U	0.796 U	0.865 U	0.926 U	**2.19 L**	1.20 U
Arsenic	18.0	**2.58**	**1.90**	**2.42**	**2.24**	**2.47**	**2.41**
Copper	70.0	**7.81**	**2.82**	**9.52**	**9.52**	**9.96**	**9.00**
Lead	120	**19.9**	**19.1**	**24.3**	**25.6**	**807**	**28.4**
Nickel	38.0	**3.79**	**3.41**	**4.98**	**4.27**	**3.74**	**6.01**
Zinc	120	**17.1**	**10.4**	**15.1**	**15.4**	**16.3**	**16.0**

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections

Table 7-5
Exceedances - Rifle Range Surface Soil - Plants and Soil Invertebrates
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Soil Screening Value	DNRR-SO08 DNRR-SS08-0610 06/16/10	DNRR-SO09 DNRR-SS09-0610 06/16/10	DNRR-SO10 DNRR-SS10-0610 06/16/10	DNRR-SO11 DNRR-SS11-0610 06/16/10	DNRR-SO12 DNRR-SS12-0610 06/15/10	DNRR-SO13 DNRR-SS13-0610 06/15/10
Inorganics (MG/KG)							
Antimony	78.0	1.19 R	1.13 U	1.14 U	0.849 U	0.846 U	0.879 U
Arsenic	18.0	1.88	1.80	6.86	1.04	1.81	1.15
Copper	70.0	6.73	2.41	10.5	2.07	4.11	4.92
Lead	120	22.6	14.8	32.4	10.1	11.8	7.50
Nickel	38.0	4.78	2.99	1.92	0.756	0.931 B	2.09
Zinc	120	15.4 K	8.70	6.60	2.75	4.42	7.11

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections

Table 7-5
Exceedances - Rifle Range Surface Soil - Plants and Soil Invertebrates
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Soil Screening Value	DNRR-SO14	DNRR-SO15		DNRR-SO16	DNRR-SO17
		DNRR-SS14-0610	DNRR-SS15-0610	DNRR-SS15P-0610	DNRR-SS16-0610	DNRR-SS17-0610
		06/15/10	06/15/10	06/15/10	06/15/10	06/15/10
Inorganics (MG/KG)						
Antimony	78.0	0.906 U	0.862 U	0.904 U	0.905 U	0.973 U
Arsenic	18.0	1.75	1.23	1.47	1.95	1.19
Copper	70.0	2.82	2.46	2.45	37.5	4.88
Lead	120	9.62	6.89	9.95	8.34	8.79
Nickel	38.0	2.78	2.65	2.54	2.94	2.29
Zinc	120	7.48	6.11	6.10	10.8	11.8

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections

Table 7-5
Exceedances - Rifle Range Surface Soil - Plants and Soil Invertebrates
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Soil Screening Value	DNRR-SO18 DNRR-SS18-0610 06/15/10	DNRR-SO19 DNRR-SS19-0610 06/15/10	DNRR-SO20 DNRR-SS20-0610 06/15/10	DNRR-SO21 DNRR-SS21-0610 06/15/10	DNRR-SO22 DNRR-SS22-0610 06/15/10
Inorganics (MG/KG)						
Antimony	78.0	0.967 U	0.752 U	0.842 U	0.813 U	0.930 U
Arsenic	18.0	**0.453**	**0.527**	**0.449**	**0.534**	**0.499**
Copper	70.0	**2.08**	**0.794**	**0.684**	**0.617**	**0.551 J**
Lead	120	**5.24**	**4.60**	**5.25**	**5.62**	**5.05**
Nickel	38.0	0.586 B	0.58 B	0.33 B	0.276 B	0.62 U
Zinc	120	**4.22**	2.03 B	1.64 B	2.06 B	1.70 B

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections

Table 7-6
Screening Statistics - Rifle Range Surface Soil - Mammal/Bird Eco-SSLs
Fleet Combat Training Center - Dam Neck Annex

Chemical	Range of Non-Detect Values	Frequency of Detection	Maximum Concentration Detected	95% UCL (Norm)	Arithmetic Mean	Mammal Eco-SSL	Frequency of Exceedance	Maximum Hazard Quotient	95% UCL Hazard Quotient	Mean Hazard Quotient	Bird Eco-SSL	Frequency of Exceedance	Maximum Hazard Quotient	95% UCL Hazard Quotient	Mean Hazard Quotient
Inorganics (MG/KG)															
Antimony	0.75 - 1.20	1 / 21	2.19	0.69	0.54	0.27	1 / 21	8.11	2.54	2.01	--	-- / --	--	--	--
Arsenic	-- - --	22 / 22	6.86	2.30	1.80	46.0	0 / 22	0.15	0.05	0.04	43.0	0 / 22	0.16	0.05	0.04
Copper	-- - --	22 / 22	37.5	12.3	8.55	49.0	0 / 22	0.77	0.25	0.17	28.0	2 / 22	1.34	0.44	0.31
Lead	-- - --	22 / 22	807	140	70.6	56.0	2 / 22	14.4	2.49	1.26	11.0	11 / 22	73.4	12.7	6.42
Nickel	0.28 - 0.93	16 / 22	17.8	5.14	3.58	130	0 / 22	0.14	0.04	0.03	210	0 / 22	0.08	0.02	0.02
Zinc	1.64 - 2.06	18 / 22	61.8	17.4	12.4	79.0	0 / 22	0.78	0.22	0.16	46.0	1 / 22	1.34	0.38	0.27

Shaded cells indicate HQ > 1

Table 7-7a
Summary of Meadow Vole Exposure Doses - Initial - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	807	1.522	a	1.23E+03	0.468	b	3.78E+02	0	4.18E+01	8.00	c	25.3	80.0	c	**5.23E+00**	**1.65E+00**	5.23E-01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0031 = Food ingestion rate (kg/day dry weight) (USEPA 1993)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.020 = Proportion of diet composed of food item (soil invertebrates) (USEPA 1993)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.956 = Proportion of diet composed of food item (terrestrial plants) (USEPA 1993)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.024 = Proportion of diet composed of soil (Beyer et al. 1994)
WIR = 0.0133 = Water ingestion rate (L/day) (USEPA 1993)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.030 = Body weight (kg) (Silva and Downing 1995)

a Sample et al. 1998a (90th percentile)
b Bechtel Jacobs 1998 (90th percentile)
c Sample et al. 1996

Table 7-7b
Summary of Meadow Vole Exposure Doses - Refined - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	70.6	Regression	a	2.50E+01	Regresson	b	2.89E+00	0	2.42E-01	8.00	c	25.3	80.0	c	3.02E-02	9.56E-03	3.02E-03

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0021 = Food ingestion rate (kg/day dry weight) (USEPA 1993)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.020 = Proportion of diet composed of food item (soil invertebrates) (USEPA 1993)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.956 = Proportion of diet composed of food item (terrestrial plants) (USEPA 1993)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.024 = Proportion of diet composed of soil (Beyer et al. 1994)
WIR = 0.0090 = Water ingestion rate (L/day) (USEPA 1993)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.0428 = Body weight (kg) (Silva and Downing 1995)

a Sample et al. 1998a
$C_w = e^{(-0.218 + 0.807(\ln Cs))}$
b Bechtel Jacobs 1998a
$C_p = e^{(-1.328 + 0.561(\ln Cs))}$
c Sample et al. 1996

Table 7-8a
Summary of Mourning Dove Exposure Doses - Initial - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	807	1.522	a	1.23E+03	0.468	b	3.78E+02	0	7.95E+01	1.13	c	3.57	11.3	c	**7.03E+01**	**2.22E+01**	**7.03E+00**

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0209 = Food ingestion rate (kg/day dry weight) (Nagy 2001)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.950 = Proportion of diet composed of food item (terrestrial plants) (Tomlinson et al. 1994)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.050 = Proportion of diet composed of soil (assumed based upon diet)
WIR = 0.0175 = Water ingestion rate (L/day) (USEPA 1993)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.105 = Body weight (kg) (Tomlinson et al. 1994)

a Sample et al. 1998a (90th percentile)
b Bechtel Jacobs 1998 (90th percentile)
c Sample et al. 1996

Table 7-8b
Summary of Mourning Dove Exposure Doses - Refined - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	70.6	Regression	a	2.50E+01	Regresson	b	2.89E+00	0	8.71E-01	1.13	c	3.57	11.3	c	7.71E-01	2.44E-01	7.71E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0176 = Food ingestion rate (kg/day dry weight) (Nagy 2001)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.950 = Proportion of diet composed of food item (terrestrial plants) (Tomlinson et al. 1994)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.050 = Proportion of diet composed of soil (assumed based upon diet)
WIR = 0.0148 = Water ingestion rate (L/day) (USEPA 1993)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.1265 = Body weight (kg) (Tomlinson et al. 1994)

a Sample et al. 1998a
$C_w = e^{(-0.218 + 0.807(\ln Cs))}$
b Bechtel Jacobs 1998a
$C_p = e^{(-1.328 + 0.561(\ln Cs))}$
c Sample et al. 1996

Table 7-9a
Summary of Short-tailed Shrew Exposure Doses - Initial - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	807	1.522	a	1.23E+03	0.468	b	3.78E+02	0	1.61E+02	8.00	c	25.3	80.0	c	**2.01E+01**	**6.35E+00**	**2.01E+00**

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI =	Chemical-specific	= Dietary intake for chemical (mg chemical/kg body weight/day)
FIR =	0.0019	= Food ingestion rate (kg/day dry weight) (USEPA 1993)
FCxi =	Chemical-specific	= Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi =	0.823	= Proportion of diet composed of food item (soil invertebrates) (Sample and Suter 1994)
FCxi =	Chemical-specific	= Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi =	0.047	= Proportion of diet composed of food item (terrestrial plants) (Sample and Suter 1994)
SCx =	Chemical-specific	= Concentration of chemical in soil (mg/kg, dry weight)
PDS =	0.130	= Proportion of diet composed of soil (Sample and Suter 1994)
WIR =	0.0048	= Water ingestion rate (L/day) (USEPA 1993)
WC =	Chemical-specific	= Concentration of chemical in water (mg/L)
BW =	0.01331	= Body weight (kg) (USEPA 1993)

a Sample et al. 1998a (90th percentile)
b Bechtel Jacobs 1998 (90th percentile)
c Sample et al. 1996

Table 7-9b
Summary of Short-tailed Shrew Exposure Doses - Refined - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	70.6	Regression	a	2.50E+01	Regresson	b	2.89E+00	0	2.64E+00	8.00	c	25.3	80.0	c	3.30E-01	1.04E-01	3.30E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0015 = Food ingestion rate (kg/day dry weight) (USEPA 1993)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.823 = Proportion of diet composed of food item (soil invertebrates) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.047 = Proportion of diet composed of food item (terrestrial plants) (Sample and Suter 1994)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.130 = Proportion of diet composed of soil (Sample and Suter 1994)
WIR = 0.0038 = Water ingestion rate (L/day) (USEPA 1993)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.01687 = Body weight (kg) (USEPA 1993)

a Sample et al. 1998a
$C_w = e^{(-0.218 + 0.807(\ln Cs))}$
b Bechtel Jacobs 1998a
$C_p = e^{(-1.328 + 0.561(\ln Cs))}$
c Sample et al. 1996

Table 7-10a
Summary of American Robin Exposure Doses - Initial - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	807	1.522	a	1.23E+03	0.468	b	3.78E+02	0	8.89E+01	3.85	c	8.61	19.3	d	**2.31E+01**	**1.03E+01**	**4.62E+00**

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0074 = Food ingestion rate (kg/day dry weight) (Levey and Karasov 1989)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.435 = Proportion of diet composed of food item (soil invertebrates) (Martin et al. 1951)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.519 = Proportion of diet composed of food item (terrestrial plants) (Martin et al. 1951)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.046 = Proportion of diet composed of soil (Sample and Suter 1994)
WIR = 0.0129 = Water ingestion rate (L/day) (USEPA 1993)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.0635 = Body weight (kg) (USEPA 1993)

a Sample et al. 1998a (90th percentile)
b Bechtel Jacobs 1998 (90th percentile)
c Sample et al. 1996
d NOAEL multiplied by 5

Table 7-10b
Summary of American Robin Exposure Doses - Refined - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	70.6	Regression	a	2.50E+01	Regresson	b	2.89E+00	0	1.12E+00	3.85	c	8.61	19.3	d	2.90E-01	1.30E-01	5.79E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI =	Chemical-specific	= Dietary intake for chemical (mg chemical/kg body weight/day)
FIR =	0.0055	= Food ingestion rate (kg/day dry weight) (Levey and Karasov 1989)
FCxi =	Chemical-specific	= Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi =	0.435	= Proportion of diet composed of food item (soil invertebrates) (Martin et al. 1951)
FCxi =	Chemical-specific	= Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi =	0.519	= Proportion of diet composed of food item (terrestrial plants) (Martin et al. 1951)
SCx =	Chemical-specific	= Concentration of chemical in soil (mg/kg, dry weight)
PDS =	0.046	= Proportion of diet composed of soil (Sample and Suter 1994)
WIR =	0.0106	= Water ingestion rate (L/day)
WC =	Chemical-specific	= Concentration of chemical in water (mg/L)
BW =	0.0773	= Body weight (kg) (USEPA 1993)

a Sample et al. 1998a
$C_w = e^{(-0.218 + 0.807(\ln Cs))}$
b Bechtel Jacobs 1998a
$C_p = e^{(-1.328 + 0.561(\ln Cs))}$
c Sample et al. 1996
d NOAEL multiplied by 5

Table 7-11a
Summary of Red Fox Exposure Doses - Initial - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Soil-Mammal BAF		Small Mammal Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	807	1.522	a	1.23E+03	0.468	b	3.78E+02	0.286	c	2.31E+02	0	1.33E+01	8.00	d	25.3	80.0	d	**1.66E+00**	5.25E-01	1.66E-01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.1476 = Food ingestion rate (kg/day dry weight) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.028 = Proportion of diet composed of food item (soil invertebrates) (USEPA 1993)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.070 = Proportion of diet composed of food item (terrestrial plants) (USEPA 1993)
FCxi = Chemical-specific = Concentration of chemical in food item (small mammals, dry weight basis)
PDFi = 0.874 = Proportion of diet composed of food item (small mammals) (USEPA 1993)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.028 = Proportion of diet composed of soil (Beyer et al. 1994)
WIR = 0.4115 = Water ingestion rate (L/day) (USEPA 1993)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 3.17 = Body weight (kg) (Silva and Downing 1995)

a Sample et al. 1998a (90th percentile)
b Bechtel Jacobs 1998 (90th percentile)
c Sample et al. 1998b (90th percentile - omnivore)
d Sample et al. 1996

Table 7-11b
Summary of Red Fox Exposure Doses - Refined - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Soil-Mammal BAF		Small Mammal Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	70.6	Regression	a	2.50E+01	Regresson	b	2.89E+00	Regresson	c	7.09E+00	0	2.75E-01	8.00	d	25.3	80.0	d	3.44E-02	1.09E-02	3.44E-03

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.1231 = Food ingestion rate (kg/day dry weight) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.028 = Proportion of diet composed of food item (soil invertebrates) (USEPA 1993)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.070 = Proportion of diet composed of food item (terrestrial plants) (USEPA 1993)
FCxi = Chemical-specific = Concentration of chemical in food item (small mammals, dry weight basis)
PDFi = 0.874 = Proportion of diet composed of food item (small mammals) (USEPA 1993)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.028 = Proportion of diet composed of soil (Beyer et al. 1994)
WIR = 0.3494 = Water ingestion rate (L/day) (USEPA 1993)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 4.06 = Body weight (kg) (Silva and Downing 1995)

a Sample et al. 1998a
$C_w = e^{(-0.218 + 0.807(\ln Cs))}$
b Bechtel Jacobs 1998a
$C_p = e^{(-1.328 + 0.561(\ln Cs))}$
c Sample et al. 1998b (omnivore)
$C_m = e^{(0.0761 + 0.4422(\ln Cs))}$
d Sample et al. 1996

Table 7-12a
Summary of Red-tailed Hawk Exposure Doses - Initial - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Soil-Mammal BAF		Small Mammal Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	807	1.522	a	1.23E+03	0.468	b	3.78E+02	0.286	c	2.31E+02	0	9.53E+00	3.85	d	8.61	19.3	e	**2.48E+00**	**1.11E+00**	4.95E-01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0395 = Food ingestion rate (kg/day dry weight) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (terrestrial plants)
FCxi = Chemical-specific = Concentration of chemical in food item (small mammals, dry weight basis)
PDFi = 1.000 = Proportion of diet composed of food item (small mammals) (Sample and Suter 1994)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.000 = Proportion of diet composed of soil (Sample and Suter 1994)
WIR = 0.0680 = Water ingestion rate (L/day) (USEPA 1993)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.957 = Body weight (kg) (USEPA 1993)

a Sample et al. 1998a (90th percentile)
b Bechtel Jacobs 1998 (90th percentile)
c Sample et al. 1998b (90th percentile - omnivore)
d Sample et al. 1996
e NOAEL multiplied by 5

Table 7-12b
Summary of Red-tailed Hawk Exposure Doses - Refined - Rifle Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Soil-Mammal BAF		Small Mammal Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	70.6	Regression	a	2.50E+01	Regresson	b	2.89E+00	Regresson	c	7.09E+00	0	2.27E-01	3.85	d	8.61	19.3	e	5.89E-02	2.63E-02	1.18E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0360 = Food ingestion rate (kg/day dry weight) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (terrestrial plants)
FCxi = Chemical-specific = Concentration of chemical in food item (small mammals, dry weight basis)
PDFi = 1.000 = Proportion of diet composed of food item (small mammals) (Sample and Suter 1994)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.000 = Proportion of diet composed of soil (Sample and Suter 1994)
WIR = 0.0639 = Water ingestion rate (L/day) (USEPA 1993)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 1.126 = Body weight (kg) (Sample and Suter 1994)

a Sample et al. 1998a
$C_w = e^{(-0.218 + 0.807(\ln Cs))}$
b Bechtel Jacobs 1998a
$C_p = e^{(-1.328 + 0.561(\ln Cs))}$
c Sample et al. 1998b (omnivore)
$C_m = e^{(0.0761 + 0.4422(\ln Cs))}$
d Sample et al. 1996
e NOAEL multiplied by 5

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\DAMNECK\SI FSAFR\FIGURE7-1_RIFLE_RANGE_SAMPLE_LOCATIONS.MXD MUNWIN 11/15/10

Legend

- MRP Sites
- Historical Ranges
- Operational Range Area
- Overlapping MRP Sites
- Rifle Range
- Soil Sample (0-12")

N W E S

0 200 400 Feet

Figure 7-1
Rifle Range Sample Locations
Site Inspection of the Former
Small Arms Firing Ranges
Dam Neck Annex, NAS Oceana
Virginia Beach, Virginia

CH2MHILL

SECTION 8

Dam Neck Annex: Skeet and Trap Range

8.1 Site Background

The former Skeet and Trap Range is located on the southwestern portion of Dam Neck Annex, on the eastern shore of Lake Tecumseh (**Figure 8-1**). More specifically, the site is situated along the northern side of Bullpup Street. The former Skeet and Trap Range was composed of four skeet ranges and four trap ranges, with approximately half of the former range area extending into Lake Tecumseh. With the presumed firing line along Bullpup Street, the direction of fire was toward the northwest, over Lake Tecumseh (Malcolm Pirnie, 2008). A 900-foot radius drawn from the presumed firing line represents the extreme range of fire for skeet and trap ranges. The resulting site area covers approximately 39 acres and was identified as the Surface Danger Zone. As observed during site reconnaissance by Malcolm Pirnie in December 2007 (Malcolm Pirnie, 2008), the southeast portion of the site, along Bullpup Street, has been developed into Building 470 and an associated parking lot. The remaining portion is composed of undeveloped forest and open water (Lake Tecumseh). During the 2007 site visit, pieces of clay targets were reportedly observed along the shoreline, in the wooded area adjacent to Bullpup Street and the parking lot, and in the shallow waters of Lake Tecumseh. Additionally, an abandoned building foundation was observed in the forested area. Although its purpose is unclear, the building is believed to have been used as a skeet or trap launching point.

Ammunition used at the former Skeet and Trap Range was expected to be 12 gauge or smaller shotgun ammunition. The primary contaminant associated with shotgun ammunition is lead. PAHs are also potential contaminants, which may be associated with the clay targets (Malcolm Pirnie, 2008).

The area of expected maximum shotfall of lead shot is a 600-foot radius from the firing point. The resulting debris is classified as both constituents from target loads and the clay targets themselves.

8.2 Rationale for Investigation

Potential sources of contamination present at the former range are debris related to small arms firing range ammunition. The COPCs associated with the debris are presumed to have a depth of less than 6 inches bgs. Because groundwater in this area is not anticipated to be affected, the SI did not evaluate groundwater as a potential route of exposure.

8.3 Field Activities

8.3.1 Visual and Metal Detector Surveys

During the sampling event, the sampling area was visually inspected as summarized in Section 3.2.

During the 2010 inspection, concrete pads were found approximately 2 inches bgs near locations DNSTR-SO03 and DNSTR-SO02. Based on the location of the concrete pads, they may have been used as the firing points. No evidence of shotgun ammunition or clay targets was found at the site. The area near the shore was heavily vegetated and prevented the field crew from observing shallow waters on the site, except for a small area on the western portion of the site that was cleared. No shot was observed in the shallow waters of that area.

A metal detector survey was not completed at the site because of the densely vegetated and inaccessible areas.

During the 2011 field event, another visual inspection was performed in the vicinity of the concrete pads and fragments of clay targets were observed. Four soil samples were collected along the suspected line of fire where fragments were found. Additionally, 11 sediment samples collected from the lake were screened for lead shot. Shot was observed in 5 of the 11 inspected samples.

8.3.2 Sample Collection

Soil Sample Collection

Discrete surface soil samples were collected from 0 to 6 inches bgs using a fan grid approach at 21 locations during the 2010 field event and at four locations during the 2011 field event. The sampling layout is shown on **Figure 8-1**. All samples, excluding four surface soil (DNSTR-SS22 through DNSTR-SS25), were analyzed for lead, while samples within the target fall zone were analyzed for PAHs.

Sediment Sample Collection

Twenty sediment samples were collected from 0-6 inches bgs from Lake Tecumseh between May 9 through 11, 2011, after HRSD was notified and permissions were granted. The sampling layout is shown on **Figure 8-1**.

8.4 Release Assessment Decision Analysis

Data for the samples collected during the field investigations were evaluated in accordance with the decision logic presented on **Figure 3-1** and approved by the project team during development of the UFP-SAP (CH2M HILL, 2010). The following subsections describe the steps in the decision process, analytical results, and an evaluation of potential risks at the former Skeet and Trap Range.

Table 8-1 presents an exceedance summary of the surface soil sample results. **Table 8-2** presents an exceedance summary of the sediment sample results. **Tables 8-3a through 8-3d**, presented at the end of this section, contain the validated analytical results of the sample investigation. The surface soil results were compared to the following screening values: RSLs for residential soil and Eco-SSLs for plants and soil invertebrates, as described in Section 3.8 and 3.9. The sediment results were compared to 10 times the RSLs for residential soil. The exceedance results are presented on **Figure 8-2**.

Sections 8.4.1 through 8.4.3 summarize the results associated with each step of the decision analysis.

TABLE 8-1
Skeet and Trap Range Soil Exceedance Summary

Total Number of Samples	Analyte	Units	Max Value	Residential Soil RSL	Number of Residential Soil RSL Exceedances	ECO-SSL	Number of ECO-SSL Exceedances
21	Lead	mg/kg	13,600	400	11/21	120	16/21
11 (PAHs)	Benzo(a) anthracene	µg/kg	302,000	150	8/11	N/A	--
11 (PAHs)	Benzo(a) pyrene	µg/kg	279,000	15	8/11	N/A	—
11 (PAHs)	Benzo(b) fluoranthene	µg/kg	329,000	150	9/11	N/A	--
11 (PAHs)	Benzo(g,h,I) perylene	µg/kg	113,000	170,000	0/11	N/A	--
11 (PAHs)	Benzo(k) fluoranthene	µg/kg	129,000	1,500	5/11	N/A	--
11(PAHs)	Chrysene	µg/kg	315,000	15,000	4/11	N/A	--
11 (PAHs)	Dibenz(a,h) anthracene	µg/kg	31,800	15	10/11	N/A	--
11 (PAHs)	Fluoranthene	µg/kg	545,000	230,000	2/11	N/A	--
11 (PAHs)	Indeno(1,2,3-cd) pyrene	µg/kg	102,000	150	8/11	N/A	--
11 (PAHs)	Naphthalene	µg/kg	8,200	3,600	2/11	N/A	--
11 (PAHs)	Pyrene	µg/kg	466,000	170,000	2/11	N/A	--
11 (PAHs)	LMW PAHs	µg/kg	1,204,118	N/A	--	29,000	4/11
11 (PAHs)	HMW PAHs	µg/kg	1,750,000	N/A	--	18,000	6/11

TABLE 8-2
Skeet and Trap Range Sediment Exceedance Summary

Total Number of Samples	Analyte	Units	Max Value	Residential Soil RSL	Number of Residential Soil RSL Exceedances	ECO-SSL	Number of ECO-SSL Exceedances
20	Lead	mg/kg	1,130	400	1/20	35.8	4/20
2 (PAHs)	Benzo(a) anthracene	µg/kg	8.22	150	0/2	N/A	--
2 (PAHs)	Benzo(a) pyrene	µg/kg	15	15	0/2	N/A	—
2 (PAHs)	Benzo(b) fluoranthene	µg/kg	10.5	150	0/2	N/A	--
2 (PAHs)	Benzo(g,h,I) perylene	µg/kg	6.38	170,000	0/2	N/A	--
2 (PAHs)	Chrysene	µg/kg	9.31	15,000	0/2	N/A	--
2 (PAHs)	Fluoranthene	µg/kg	25.6	230,000	0/2	N/A	--
2 (PAHs)	Indeno(1,2,3-cd) pyrene	µg/kg	4.78	150	0/2	N/A	--
2 (PAHs)	Phenanthrene	µg/kg	13.7	17,000,000	0/2	N/A	--
2 (PAHs)	Pyrene	µg/kg	18.9	170,000	0/2	N/A	--
2 (PAHs)	LMW PAHs	µg/kg	1,204,118	N/A	--	786	0/2
2 (PAHs)	HMW PAHs	µg/kg	1,750,000	N/A	--	2,900	0/2

8.4.1 Step 1

Twenty-five surface soil samples and twenty sediment samples were collected at the Skeet and Trap Range during the field sampling activities. In Step 1, the sample results were compared to the human health and ecological screening levels. As shown in **Table 8-1**, surface soil sample results exceeded the screening levels at a majority of the locations.

On the basis of these exceedances, the decision analysis followed the path to Step 2.

8.4.2 Step 2

Because of the magnitude of lead and PAH exceedances in both soil and sediment, more-realistic evaluations of the data were undertaken to decide if further action would be necessary. Potential ecological and human health risks were evaluated. The results of these evaluations are discussed as follows. COPCs were identified in the human health and ecological evaluations, so the decision analysis followed the path to Step 3.

HHRS Results

The risk-based screening evaluation for surface soil at the Dam Neck Annex Skeet and Trap Range is presented in **Tables 8-4 through 8-4b**. The risk-based screening evaluation for sediment is presented in **Table 8-5**.

Surface Soil

Tables 8-4 through 8-4b present the risk-based screening evaluation for surface soil. Lead and 10 PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, and pyrene) were retained for evaluation in Step 2. Based on Step 2 (risk ratio using maximum detected concentrations), eight of the PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene) were carried forward to Step 3. Based on Step 3 (risk ratio using 95% UCLs), the eight PAHs could not be eliminated and were retained as COPCs for surface soil.

Except for naphthalene, PAHs were detected in all of the samples in which they were analyzed, with the highest detected concentrations in sample DNSTR-SS22-0511.

The average lead concentration in the surface soil, 1,274 mg/kg, exceeds the lead screening level. Lead, along with PAHs, are considered COPCs for surface soil.

Sediment

Table 8-4 presents the risk-based screening evaluation for sediment. Lead was the only constituent that exceeded the screening level in Step 1 based on the maximum detected concentration. However, the average lead concentration in the sediment, 76 mg/kg, is below the lead screening level, and as a result, lead is not considered a COPC for sediment. Therefore, sediment does not pose an unacceptable human health risk.

HHRS Summary

Based on the HHRS evaluation for the Dam Neck Annex Skeet and Trap Range, potential unacceptable risks associated with PAHs and lead were identified for surface soil. No risks were identified with exposure to sediment. In order to assess the risk associated with surface soil based on anticipated receptors (recreational users/visitors, trespassers, maintenance workers, and industrial workers), a more-quantitative risk assessment is needed.

Ecological Risk Screening Results

The results of the ecological risk evaluation for the Skeet and Trap Range are presented in **Tables 8-6 through 8-23**.

Surface Soil

Maximum concentrations of lead and PAHs (both LMW and HMW) exceeded ecological soil screening values for plants and soil invertebrates (**Table 8-6**). As a result, lead and PAHs were identified as initial COPCs. The initial COPCs were evaluated using more-realistic assumptions, as follows:

- HMW PAHs exceeded screening values in 6 of 11 samples (**Table 8-7**) at a maximum HQ of 97.2. The mean HQs also exceeded 1 for both groups of PAHs. Therefore, HMW and LMW PAHs were identified as refined COPCs.
- Lead exceeded screening values in 16 of 21 samples. There were exceedances at all sampling locations, except those right at the firing line (SO-01 through SO-04) and in one (SO-18) of the most distant samples from the firing line (**Table 8-7**). The mean HQ for lead exceeded 10. Thus, lead was identified as a refined COPC.

Terrestrial Food Web Exposures

Lead and PAHs were first screened against bird and/or mammal Eco-SSLs (**Table 8-8**). Lead and PAHs (both HMW and LMW) exceeded Eco-SSLs, based upon maximum detected concentrations as well as mean and 95% UCL concentrations. Therefore, site-specific food web modeling was conducted for lead and PAHs (only the individual PAH compounds on the list of bioaccumulative chemicals in USEPA guidance [2000] were evaluated) using the following receptor species:

- American robin (*Turdus migratorius*) - terrestrial avian invertivore/omnivore
- Meadow vole (*Microtus pennsylvanicus*) - terrestrial mammalian herbivore
- Mourning dove (*Zenaida macroura*) - terrestrial avian herbivore

- Red fox (*Vulpes vulpes*) - terrestrial mammalian carnivore
- Red-tailed hawk (*Buteo jamaicensis*) - terrestrial avian carnivore
- Short-tailed shrew (*Blarina brevicauda*) - terrestrial mammalian invertivore

The results of the site-specific food web modeling are contained in **Tables 8-9 through 8-14**.

For lead, NOAEL-, MATC-, and LOAEL-based HQs using maximum surface soil concentrations and conservative exposure assumptions exceeded 1 for all six of these receptors. NOAEL- and MATC-based HQs also exceeded 1 for three of the receptors (mourning dove, short-tailed shrew, and American robin) when mean surface soil concentrations and more-realistic exposure assumptions were used. LOAEL-based HQs exceeded 1 only for the short-tailed shrew. Based upon the analysis, lead was identified as a refined COPC for terrestrial food web exposures.

For PAHs, NOAEL-based HQs exceeded 1 using maximum surface soil concentrations and conservative exposure assumptions for at least one LMW PAH and at least one HMW PAH for at least one receptor. NOAEL-based HQs also exceeded 1 for three of the receptors (mourning dove, short-tailed shrew, and meadow vole) when mean surface soil concentrations and more-realistic exposure assumptions were used, while MATC-based HQs exceeded 1 for two receptors (short-tailed shrew and meadow vole). Pyrene had the highest exceedances and was the only PAH whose LOAEL-based HQ exceeded 1 (for the short-tailed shrew). Several other HMW PAHs also exceeded the MATC (but not the LOAEL), while none of the LMW PAHs exceeded the MATC or the LOAEL. Based upon this analysis, HMW PAHs were identified as refined COPCs for terrestrial food web exposures.

Sediment

Maximum concentrations of lead exceeded ecological sediment screening values (**Table 8-15**). As a result, lead was identified as an initial COPC. The initial COPCs were evaluated using more-realistic assumptions, as follows:

- Lead exceeded screening values in 4 of 20 samples. Although the mean HQ exceeded 1, this was driven by a high concentration (1,130 mg/kg) at SD-09 and, to a lesser extent, by another elevated concentration (130 mg/kg) at SD-10 (**Table 8-16**). The other two exceedances were at less than 2 times the screening value. Because the mean HQ for lead exceeded 1, it was identified as a refined COPC. However, potential ecological effects would likely be spatially restricted. SD-09 and SD-10 were within the expected highest shot fall area based upon distance from the firing positions, although no pellets were found in either sample. The highest pellet count was found at SD-08, also in the expected highest shot fall area, although the lead concentration was much lower (6.49 mg/kg) and did not exceed the screening value.

Aquatic Food Web Exposures

Site-specific food web modeling was conducted for lead and PAHs (only the individual PAH compounds on the list of bioaccumulative chemicals in USEPA guidance [2000] were evaluated) using the following receptor species:

- Belted kingfisher (*Ceryle alcyon*) - semi-aquatic avian piscivore/invertivore
- Great blue heron (*Ardea herodias*) - semi-aquatic avian piscivore
- Mallard (*Anas platyrhynchos*) - semi-aquatic avian omnivore
- Marsh wren (*Cistothorus palustris*) - semi-aquatic avian insectivore
- Mink (*Mustela vison*) - semi-aquatic mammalian piscivore
- Muskrat (*Ondatra zibethicus*) - semi-aquatic mammalian herbivore
- Raccoon (*Procyon lotor*) - semi-aquatic mammalian omnivore

The results of the site-specific food web modeling are contained in **Tables 8-17 through 8-23**. There were no exceedances for PAHs even under the most conservative scenario. Therefore, PAHs were not identified as initial or refined COPCs.

For lead, NOAEL-, MATC-, and LOAEL-based HQs using maximum surface sediment concentrations and conservative exposure assumptions exceeded 1 for five of these seven receptors. Thus, lead was identified as an initial COPC. There were no exceedances based upon the NOAEL when mean surface sediment concentrations and more-realistic exposure assumptions were used. Because of this, lead was not identified as a refined COPC for aquatic food web exposures.

Ecological Risk Screening Summary

Lead and PAHs were identified as COPCs in Skeet and Trap Range surface soil and for terrestrial food web exposures. As a result, there is the potential for unacceptable ecological risks to occur in terrestrial areas of this site from exposure to these constituents. Lead was identified as a COPC in Skeet and Trap Range sediments collected from Lake Tecumseh for direct exposures of lower trophic level receptors but not for aquatic food web exposures. However, potential ecological effects would likely be spatially restricted based upon the spatial distribution of lead and pellets in lake sediments.

8.4.3 Step 3

Step 3 Soil

Lead and PAHs were identified as COPCs in Step 2. In Step 3, the COPC results were compared to the established background values for eastern Virignia (presented in Section 3.7). All results exceeded background values, so a potential release is suspected.

Step 3 Sediment

Lead was identified as a COPC in sediment for ecological receptors; however, no sediment background data are available for comparison. Conclusions and recommendations regarding sediment therefore were based on results of Steps 1 and 2 of the decision analysis process.

8.5 Summary and Conclusions

Based on the HHRS evaluation for Dam Neck Annex Skeet and Trap Range, potential unacceptable risks were identified for surface soil, associated with PAHs and lead.

Based on the ecological risk evaluation, lead and PAHs were identified as COPCs in surface soil and for terrestrial food web exposures. Therefore, there is the potential for unacceptable ecological risks to occur at this site from exposure to lead in terrestrial habitats.

Lead was also identified as a COPC in sediments collected from Lake Tecumseh for direct exposures to lower trophic level receptors; however, potential risks would likely be spatially restricted based upon the distribution of lead and pellets in lake sediments.

A remedial investigation is recommended to further delineate the lateral and vertical extent of PAH and lead contamination in the soils and to establish site-specific background levels for lead. In addition, quantitative HHRAs and ERAs should be conducted to assess risk based on anticipated receptors.

Although lead exceeded human health screening criteria at one sediment sampling location, the average concentration of 76 mg/kg was less than the screening level and there were no unacceptable human health risks identified. Only minimal unacceptable ecological risks were identified due to exposure to lead in sediment, in a spatially limited area. Further investigation of sediment is recommended to evaluate these limited potential risks.

TABLE 8-3a
Soil Sample Analytical Results (Lead)
Skeet and Trap Range - Dam Neck Annex

Station ID	CLEAN RSLs	ECO PAL	DNSTR-SO01	DNSTR-SO02	DNSTR-SO03	DNSTR-SO04	DNSTR-SO05	DNSTR-SO06
Sample ID	Residential Soil		DNSTR-SS01-0610	DNSTR-SS02-0610	DNSTR-SS03-0610	DNSTR-SS04-0610	DNSTR-SS05-0610	DNSTR-SS06-0610
Sample Date	Adjusted 0510		06/17/10	06/17/10	06/17/10	06/17/10	06/17/10	06/17/10
Total Metals (MG/KG)								
Lead	400	120	**33.3**	**87.7**	**90.7**	**59.8**	**242**	**1,590**

Station ID	CLEAN RSLs	ECO PAL	DNSTR-SO07	DNSTR-SO08	DNSTR-SO09	DNSTR-SO10	DNSTR-SO11	DNSTR-SO12
Sample ID	Residential Soil		DNSTR-SS07-0610	DNSTR-SS08-0610	DNSTR-SS09-0610	DNSTR-SS10-0610	DNSTR-SS11-0610	DNSTR-SS12-0610
Sample Date	Adjusted 0510		06/17/10	06/17/10	06/17/10	06/17/10	06/17/10	06/17/10
Total Metals (MG/KG)								
Lead	400	120	**129**	**2,340**	**735**	**624**	**1,810**	**13,600**

Station ID	CLEAN RSLs	ECO PAL	DNSTR-SO13	DNSTR-SO14	DNSTR-SO15	DNSTR-SO16	DNSTR-SO17	DNSTR-SO18
Sample ID	Residential Soil		DNSTR-SS13-0610	DNSTR-SS14-0610	DNSTR-SS15-0610	DNSTR-SS16-0610	DNSTR-SS17-0610	DNSTR-SS18-0610
Sample Date	Adjusted 0510		06/17/10	06/17/10	06/17/10	06/17/10	06/17/10	06/17/10
Total Metals (MG/KG)								
Lead	400	120	**536**	**1,760**	**311**	**1,070**	**401**	**55.1**

Station ID	CLEAN RSLs	ECO PAL	DNSTR-SO19	DNSTR-SO20	DNSTR-SO21
Sample ID	Residential Soil		DNSTR-SS19-0610	DNSTR-SS20-0610	DNSTR-SS21-0610
Sample Date	Adjusted 0510		06/17/10	06/17/10	06/17/10
Total Metals (MG/KG)					
Lead	400	120	**708**	**371**	**208**

Notes:

Exceeds RSL

Exceeds ECO

Bold indicates detections

NA - Not analyzed

B - Analyte not detected above the level reported in blanks

J - Analyte present, value may or may not be accurate or precise

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

MG/KG - milligrams per kilogram

Table 8-3b
Soil Sample Analytical Results (PAHs)
Skeet and Trap Range - Dam Neck Annex

Station ID	CLEAN RSLs	ECO PAL	DNSTR-SO01	DNSTR-SO02	DNSTR-SO03	DNSTR-SO04	DNSTR-SO05	DNSTR-SO06	DNSTR-SO07
Sample ID	Residential Soil		DNSTR-SS01-0610	DNSTR-SS02-0610	DNSTR-SS03-0610	DNSTR-SS04-0610	DNSTR-SS05-0610	DNSTR-SS06-0610	DNSTR-SS07-0610
Sample Date	Adjusted 0611		06/17/10	06/17/10	06/17/10	06/17/10	06/17/10	06/17/10	06/17/10
Semivolatile Organic Compounds (UG/KG)									
2-Methylnaphthalene	31,000	LMW PAH	**14.1 J**	**10.1 J**	**24.4 J**	33.4 U	**1.51 J**	6.67 U	**2.19 L**
Acenaphthene	340,000	LMW PAH	**68.7**	**46.5**	**109**	**19.7 J**	**2.52 J**	**3.08 J**	**5.09 J**
Acenaphthylene	--	LMW PAH	33.4 U	33.4 U	33.4 U	33.4 U	**3.55 J**	**1.76 J**	6.67 U
Anthracene	1,700,000	LMW PAH	**210**	**166**	**382**	33.4 U	**7.96**	6.67 U	**33.5 L**
Benzo(a)anthracene	150	HMW PAH	**2,180**	**1,420**	**3,300**	**639**	**75.5**	**73.6**	**133 L**
Benzo(a)pyrene	15	HMW PAH	**2,480**	**1,700**	**3,520**	**801**	**84.1**	**87.4**	**127 L**
Benzo(b)fluoranthene	150	HMW PAH	**3,370**	**2,290**	**4,670**	**1,070**	**113**	**117**	**177 L**
Benzo(g,h,i)perylene	170,000	HMW PAH	**1,540**	**1,160**	**2,180**	**549**	**57.8**	**56**	**79.7 L**
Benzo(k)fluoranthene	1,500	HMW PAH	**1,160**	**834**	**1,680**	**410**	**44.3**	**45.2**	**65.4 L**
Chrysene	15,000	HMW PAH	**2470**	**1,680**	**3610**	**771**	**83.4**	**87.2**	**154 L**
Dibenz(a,h)anthracene	15	HMW PAH	**378**	**285**	**564**	**136**	**15.8**	**13.5**	**21.2 L**
Fluoranthene	230,000	LMW PAH	**3,330**	**2,160**	**4900**	**942**	**108**	**110**	**271 L**
Fluorene	230,000	LMW PAH	**28.7 J**	**25.3 J**	**61.8**	33.4 U	**2.34 J**	6.67 U	**5.72 J**
Indeno(1,2,3-cd)pyrene	150	HMW PAH	**1,760**	**1,270**	**2,430**	**583**	**67.6**	**62**	**86.7**
Naphthalene	3,600	LMW PAH	**42.7**	**32.6 J**	**75.3**	**16.3 J**	4.92 B	2.66 B	4.96 B
Phenanthrene	1,700,000	LMW PAH	**953**	**715**	**1,680**	**291**	**33.9**	**30.4**	**143 L**
Pyrene	170,000	HMW PAH	**2,990**	**1,890**	**4,290**	**854**	**99.7**	**100**	**218 L**
PAH (HMW)	N/A	18,000	**18,328**	**12,529**	**26,244**	**5,813**	**641**	**642**	**1,062**
PAH (LMW)	N/A	29,000	**4,664**	**3,172**	**7,249**	**1,336**	**162**	**157**	**466**

Station ID	CLEAN RSLs	ECO PAL	DNSTR-SS22	DNSTR-SS23	DNSTR-SS24	DNSTR-SS25
Sample ID	Residential Soil		DNSTR-SS22-0511	DNSTR-SS23-0511	DNSTR-SS24-0511	DNSTR-SS25-0511
Sample Date	Adjusted 0611		05/11/11	05/11/11	05/11/11	05/11/11
Semivolatile Organic Compounds (UG/KG)						
2-Methylnaphthalene	31,000	LMW PAH	**3,430**	**610**	**1,340**	**543**
Acenaphthene	340,000	LMW PAH	**13,500**	**4,270**	**6,440**	**2,500**
Acenaphthylene	--	LMW PAH	176 U	212 U	236 U	191 U
Anthracene	1,700,000	LMW PAH	**54,000**	**10,900**	**24,400**	**14,000**
Benzo(a)anthracene	150	HMW PAH	**302,000**	**111,000**	**170,000**	**65,400**
Benzo(a)pyrene	15	HMW PAH	**279,000**	**110,000**	**135,000**	**46,800**
Benzo(b)fluoranthene	150	HMW PAH	**329,000**	**141,000**	**180,000**	**55,600**
Benzo(g,h,i)perylene	170,000	HMW PAH	**113,000**	**54,400**	**70,000**	**19,600**
Benzo(k)fluoranthene	1,500	HMW PAH	**129,000**	**53,500**	**75,000**	**21,400**
Chrysene	15,000	HMW PAH	**315,000**	**126,000**	**190,000**	**66,300**
Dibenz(a,h)anthracene	15	HMW PAH	**31,800**	**17,100**	**19,800**	**7,120**
Fluoranthene	230,000	LMW PAH	**545,000**	**173,000**	**254,000**	**106,000**
Fluorene	230,000	LMW PAH	**10,100**	212 U	**5,030**	**2,600**
Indeno(1,2,3-cd)pyrene	150	HMW PAH	**102,000**	**54,900**	**63,200**	**21,700**
Naphthalene	3,600	LMW PAH	**8,200**	**2,050**	**4,170**	**1,620**
Phenanthrene	1,700,000	LMW PAH	**253,000**	**48,000**	**97,100**	**58,000**
Pyrene	170,000	HMW PAH	**466,000**	**161,000**	**202,000**	**93,300**
PAH (HMW)	N/A	18,000	**1,750,000**	**677,050**	**927,970**	**324,440**
PAH (LMW)	N/A	29,000	**1,204,118**	**390,892**	**569,628**	**258,139**

Notes:
Exceeds ECO PALs
Bold indicates detections
NA - Not analyzed
B - Analyte not detected above the level reported in blanks
J - Analyte present, value may or may not be accurate or precise
L - Analyte present, value may be biased low, actual value may be higher
U - The material was analyzed for, but not detected
UG/KG - micrograms per kilogram

TABLE 8-3c
Sediment Sample Analytical Results (Lead and Wet Chemistry)
Skeet and Trap Range
Dam Neck Annex

Station ID	RSLs Residential Soil Adjusted 0611	Ecological Sediment Screening	DNSTR-SD01		DNSTR-SD02	DNSTR-SD03	DNSTR-SD04	DNSTR-SD05	DNSTR-SD06
Sample ID			DNSTR-SD01-0511	DNSTR-SD01P-0511	DNSTR-SD02-0511	DNSTR-SD03-0511	DNSTR-SD04-0511	DNSTR-SD05-051	DNSTR-SD06-051
Sample Date			05/09/11	05/09/11	05/09/11	05/10/11	05/10/11	05/10/11	05/10/11
Total Metals (MG/KG)									
Lead	400	35.8	**11.7**	**10.2**	**33.8** J	**12.3**	**11.7**	**11**	**8.07**
Wet Chemistry									
pH	--	--	6.78	7.04	6.67	7.03	6.8	NA	NA
Total organic carbon (mg/kg)	--	--	3,550	3,100	2,130	4,660	5,340	NA	NA

Station ID	RSLs Residential Soil Adjusted	Ecological Sediment Screening	DNSTR-SD07	DNSTR-SD08	DNSTR-SD09	DNSTR-SD10	DNSTR-SD11	DNSTR-SD12	DNSTR-SD13
Sample ID			DNSTR-SD07-0511	DNSTR-SD08-0511	DNSTR-SD09-0511	DNSTR-SD10-0511	DNSTR-SD11-0511	DNSTR-SD12-051	DNSTR-SD13-051
Sample Date			05/10/11	05/10/11	05/10/11	05/10/11	05/10/11	05/10/11	05/10/11
Total Metals (MG/KG)									
Lead	400	35.8	**12.5**	**6.49**	**1,130**	**130**	**14.2**	**14.1**	**60.7**
Wet Chemistry									
pH	--	--	6.18	6.88	6.76	6.16	NA	NA	6.35
Total organic carbon (mg/kg)	--	--	7,640	8,930	11,300	1,900	NA	NA	52,800

Station ID	RSLs Residential Soil Adjusted	Ecological Sediment Screening	DNSTR-SD14	DNSTR-SD15	DNSTR-SD16	DNSTR-SD17		DNSTR-SD18	DNSTR-SD19	DNSTR-SD20
Sample ID			DNSTR-SD14-0511	DNSTR-SD15-0511	DNSTR-SD16-0511	DNSTR-SD17-0511	DNSTR-SD17P-0511	DNSTR-SD18-051	DNSTR-SD19-051	DNSTR-SD20-0511
Sample Date			05/10/11	05/10/11	05/10/11	05/10/11	05/10/11	05/10/11	05/10/11	05/10/11
Total Metals (MG/KG)										
Lead	400	35.8	**18.8**	**17.9**	**27.1**	**48.8**	**41.8**	**6.54**	**28.5**	**11.9**
Wet Chemistry										
pH	--	--	6.86	6.75	6.75	NA	NA	6.72	6.94	6.91
Total organic carbon (mg/kg)	--	--	25,500	3,230	41,800	NA	NA	9,180	3,930	2,040

Notes:
Exceeds RSL
Exceeds ECO
Bold indicates detections
NA - Not analyzed
J - Analyte present, value may or may not be accurate or precise
U - The material was analyzed for, but not detected
UJ - Analyte not detected, quantitation limit may be inaccurate
MG/KG - milligrams per kilogram

TABLE 8-3d
Sediment Sample Analytical Results (PAHs)
Skeet and Trap Range
Dam Neck Annex

Station ID	RSLs Residential Soil Adjusted 0611	Ecological Sediment Screening Value	DNSTR-SD01		DNSTR-SD02
Sample ID			DNSTR-SD01-0511	DNSTR-SD01P-0511	DNSTR-SD02-0511
Sample Date			05/09/11	05/09/11	05/09/11
Semivolatile Organic Compounds (UG/KG)					
2-Methylnaphthalene	31,000	20.2	3.91 U	4.12 U	4.22 UJ
Acenaphthene	340,000	290	3.91 U	4.12 U	4.22 UJ
Acenaphthylene	--	160	3.91 U	4.12 U	4.22 UJ
Anthracene	1,700,000	57.2	**2.77 J**	4.12 U	4.22 UJ
Benzo(a)anthracene	150	108	**8.22**	4.12 U	4.22 UJ
Benzo(a)pyrene	15	150	**9.26**	4.12 U	4.22 UJ
Benzo(b)fluoranthene	150	240	**10.5**	4.12 U	4.22 UJ
Benzo(g,h,i)perylene	170,000	170	**6.38 J**	4.12 U	4.22 UJ
Benzo(k)fluoranthene	1,500	240	3.91 U	4.12 U	4.22 UJ
Chrysene	15,000	166	**9.31**	4.12 U	4.22 UJ
Dibenz(a,h)anthracene	15	33	3.91 U	4.12 U	4.22 UJ
Fluoranthene	230,000	423	**25.6 J**	4.12 UJ	**2.28 J**
Fluorene	230,000	77.4	3.91 U	4.12 U	4.22 UJ
Indeno(1,2,3-cd)pyrene	150	200	**4.78 J**	4.12 U	4.22 UJ
Naphthalene	3,600	176	3.91 U	4.12 U	4.22 UJ
Phenanthrene	1,700,000	204	**13.7**	4.12 U	4.22 UJ
Pyrene	170,000	195	**18.9 J**	4.12 UJ	4.22 UJ
PAH (HMW)	N/A	2,900	**71.3**	18.5 U	19.0 U
PAH (LMW)	N/A	786	**51.8**	16.5 U	**17.1**
PAH (total)	N/A	3,553	**123**	35.0 U	**36.0**

Notes:

Exceeds RSL

Exceeds ECO

Bold indicates detections

NA - Not analyzed

J - Analyte present, value may or may not be accurate or precise

U - The material was analyzed for, but not detected

UJ - Analyte not detected, quantitation limit may be inaccurate

UG/KG - micrograms per kilogram

TABLE 8-4

Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Surface Soil

Skeet and Trap Range

Dam Neck Annex

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration	Qualifier	Maximum [1] Concentration	Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening Toxicity Value [4]		Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface Soil	91-57-6	2-Methylnaphthalene	1.5E-03	J	3.4E+00		MG/KG	DNSTR-SS22-0511	9/11	0.00667 - 0.473	3.4E+00	N/A	3.1E+01	N	7.5E-01	SSL	NO	BSL
	83-32-9	Acenaphthene	2.5E-03	J	1.4E+01		MG/KG	DNSTR-SS22-0511	11/11	0.00667 - 0.473	1.4E+01	N/A	3.4E+02	N	2.2E+01	SSL	NO	BSL
	208-96-8	Acenaphthylene	1.8E-03	J	3.6E-03	J	MG/KG	DNSTR-SS05-0610	2/11	0.00667 - 0.473	3.6E-03	N/A	3.4E+02	N			NO	BSL
	120-12-7	Anthracene	8.0E-03		5.4E+01		MG/KG	DNSTR-SS22-0511	9/11	0.00667 - 0.473	5.4E+01	N/A	1.7E+03	N	3.6E+02	SSL	NO	BSL
	56-55-3	**Benzo(a)anthracene**	**7.4E-02**		**3.0E+02**		**MG/KG**	**DNSTR-SS22-0511**	**11/11**	**0.00667 - 3.53**	**3.0E+02**	**N/A**	**1.5E-01**	**C**	**1.0E-02**	**SSL**	**YES**	**ASL**
	50-32-8	**Benzo(a)pyrene**	**8.4E-02**		**2.8E+02**		**MG/KG**	**DNSTR-SS22-0511**	**11/11**	**0.00667 - 3.53**	**2.8E+02**	**N/A**	**1.5E-02**	**C**	**3.5E-03**	**SSL**	**YES**	**ASL**
	205-99-2	**Benzo(b)fluoranthene**	**1.1E-01**		**3.3E+02**		**MG/KG**	**DNSTR-SS22-0511**	**11/11**	**0.00667 - 3.53**	**3.3E+02**	**N/A**	**1.5E-01**	**C**	**3.5E-02**	**SSL**	**YES**	**ASL**
	191-24-2	Benzo(g,h,i)perylene	5.6E-02		1.1E+02		MG/KG	DNSTR-SS22-0511	11/11	0.00667 - 0.473	1.1E+02	N/A	1.7E+02	N			NO	BSL
	207-08-9	**Benzo(k)fluoranthene**	**4.4E-02**		**1.3E+02**		**MG/KG**	**DNSTR-SS22-0511**	**11/11**	**0.00667 - 0.473**	**1.3E+02**	**N/A**	**1.5E+00**	**C**	**3.5E-01**	**SSL**	**YES**	**ASL**
	218-01-9	**Chrysene**	**8.3E-02**		**3.2E+02**		**MG/KG**	**DNSTR-SS22-0511**	**11/11**	**0.00667 - 3.53**	**3.2E+02**	**N/A**	**1.5E+01**	**C**	**1.1E+00**	**SSL**	**YES**	**ASL**
	53-70-3	**Dibenz(a,h)anthracene**	**1.4E-02**		**3.2E+01**		**MG/KG**	**DNSTR-SS22-0511**	**11/11**	**0.00667 - 0.473**	**3.2E+01**	**N/A**	**1.5E-02**	**C**	**1.1E-02**	**SSL**	**YES**	**ASL**
	206-44-0	**Fluoranthene**	**1.1E-01**		**5.5E+02**		**MG/KG**	**DNSTR-SS22-0511**	**11/11**	**0.00667 - 4.73**	**5.5E+02**	**N/A**	**2.3E+02**	**N**	**1.6E+02**	**SSL**	**YES**	**ASL**
	86-73-7	Fluorene	2.3E-03	J	1.0E+01		MG/KG	DNSTR-SS22-0511	8/11	0.00667 - 0.473	1.0E+01	N/A	2.3E+02	N	2.7E+01	SSL	NO	BSL
	193-39-5	**Indeno(1,2,3-cd)pyrene**	**6.2E-02**		**1.0E+02**		**MG/KG**	**DNSTR-SS22-0511**	**11/11**	**0.00667 - 0.473**	**1.0E+02**	**N/A**	**1.5E-01**	**C**	**1.2E-01**	**SSL**	**YES**	**ASL**
	91-20-3	**Naphthalene**	**1.6E-02**	**J**	**8.2E+00**		**MG/KG**	**DNSTR-SS22-0511**	**8/11**	**0.00667 - 0.473**	**8.2E+00**	**N/A**	**3.6E+00**	**C***	**4.7E-04**	**SSL**	**YES**	**ASL**
	85-01-8	Phenanthrene	3.0E-02		2.5E+02		MG/KG	DNSTR-SS22-0511	11/11	0.00667 - 3.53	2.5E+02	N/A	1.7E+03	N			NO	BSL
	129-00-0	**Pyrene**	**1.0E-01**		**4.7E+02**		**MG/KG**	**DNSTR-SS22-0511**	**11/11**	**0.00667 - 3.53**	**4.7E+02**	**N/A**	**1.7E+02**	**N**	**1.2E+02**	**SSL**	**YES**	**ASL**
	7439-92-1	**Lead**	**3.3E+01**		**1.4E+04**		**MG/KG**	**DNSTR-SS12-0610**	**21/21**	**0.16 - 6.49**	**1.4E+04**	**N/A**	**4.0E+02**	**NL**			**YES**	**ASL**

Notes:

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). June , 2011. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. [Online].
Available: http://epa-prgs.ornl.gov/chemicals/index.shtml. Adjusted (noncarcinogenic RSLs adjusted by dividing by 10) residential soil RSLs.
The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.
RSL value for Acenaphthene used as surrogate for Acenaphthylene.
RSL value for Pyrene used as surrogate for Benzo(g,h,i)perylene.
RSL value for Anthracene used as surrogate for Phenanthrene.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered

SSL = Protection of groundwater risk-based SSL from RSL Table

C = Carcinogenic

C* = N screening level < 100x C screening level, therefore N screening value/10 used as screening level

N = Noncarcinogenic

N/A = Not available

NL = Noncarcinongenic lead residential soil RSL not adjusted by dividing by 10.

J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.

TABLE 8-4a

Risk Ratio Screening for Surface Soil, Maximum Detected Concentration in Surface Soil

Skeet and Trap Range

Dam Neck Annex

Analyte	Detection Frequency	Detected Concentration (Qualifier)	Sample	Screening Level Residential Soil	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
SVOCs (mg/kg)								
Benzo(a)anthracene	**11 / 11**	**3.0E+02**	**DNSTR-SS22-0511**	**1.5E-01**	**1E-06**	**NA**	**2E-03**	**NA**
Benzo(a)pyrene	**11 / 11**	**2.8E+02**	**DNSTR-SS22-0511**	**1.5E-02**	**1E-06**	**NA**	**2E-02**	**NA**
Benzo(b)fluoranthene	**11 / 11**	**3.3E+02**	**DNSTR-SS22-0511**	**1.5E-01**	**1E-06**	**NA**	**2E-03**	**NA**
Benzo(k)fluoranthene	**11 / 11**	**1.3E+02**	**DNSTR-SS22-0511**	**1.5E+00**	**1E-06**	**NA**	**9E-05**	**NA**
Chrysene	**11 / 11**	**3.2E+02**	**DNSTR-SS22-0511**	**1.5E+01**	**1E-06**	**NA**	**2E-05**	
Dibenz(a,h)anthracene	**11 / 11**	**3.2E+01**	**DNSTR-SS22-0511**	**1.5E-02**	**1E-06**	**NA**	**2E-03**	**NA**
Fluoranthene	11 / 11	5.5E+02	DNSTR-SS22-0511	2.3E+03	1	0.2	NA	Kidney, Liver
Indeno(1,2,3-cd)pyrene	**11 / 11**	**1.0E+02**	**DNSTR-SS22-0511**	**1.5E-01**	**1E-06**	**NA**	**7E-04**	**NA**
Naphthalene	**8 / 11**	**8.2E+00**	**DNSTR-SS22-0511**	**3.6E+00**	**1E-06**	**NA**	**2E-06**	
Pyrene	11 / 11	4.7E+02	DNSTR-SS22-0511	1.7E+03	1	0.3	NA	Kidney
Metals (mg/kg)								
Lead	**21 / 21**	**1.4E+04**	**DNSTR-SS12-0610**	**NA**	**NA**	**NA**	**NA**	**NA**
Cumulative Corresponding Hazard Index[c]						**0.5**		
Cumulative Corresponding Cancer Risk[d]							**3E-02**	
							Total Kidney HI =	0.5
							Total Liver HI =	0.2

[a] Corresponding Hazard Index equals maximum detected concentration divided by the RBC divided by the acceptable risk level.

[b] Corresponding Cancer Risk equals maximum detected concentration divided by the RBC divided by the acceptable risk level.

[c] Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

[d] Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Chemical of Potential Concern

HI = Hazard Index

mg/kg = Milligrams per kilogram

NA = Not available/not applicable.

TABLE 8-4b

Risk Ratio Screening for Surface Soil, 95% UCL Concentration in Surface Soil

Skeet and Trap Range

Dam Neck Annex

Analyte	Detection Frequency			95% UCL		95% UCL Rationale	Screening Level	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
SVOCs (mg/kg)											
Benzo(a)anthracene	11	/	11	3.0E+02	Max	5	1.5E-01	1E-06	NA	2E-03	NA
Benzo(a)pyrene	11	/	11	2.6E+02	95% Adj-G	1, 3	1.5E-02	1E-06	NA	2E-02	NA
Benzo(b)fluoranthene	11	/	11	3.2E+02	95% Adj-G	1, 3	1.5E-01	1E-06	NA	2E-03	NA
Benzo(k)fluoranthene	11	/	11	1.3E+02	95% Adj-G	1, 3	1.5E+00	1E-06	NA	9E-05	NA
Chrysene	11	/	11	3.2E+02	Max	5	1.5E+01	1E-06	NA	2E-05	NA
Dibenz(a,h)anthracene	11	/	11	3.2E+01	Max	5	1.5E-02	1E-06	NA	2E-03	NA
Indeno(1,2,3-cd)pyrene	11	/	11	1.0E+02	95% Adj-G	1, 3	1.5E-01	1E-06	NA	7E-04	NA
Naphthalene	8	/	11	5.0E+00	95% KM	1, 3	3.6E+00	1E-06	NA	1E-06	NA
Metals (mg/kg)											
Lead	21	/	21	1.3E+03	Mean	6	NA	NA	NA	NA	NA
Cumulative Corresponding Hazard Index[c]									NA		
Cumulative Corresponding Cancer Risk[d]										2E-02	

[a] Corresponding Hazard Index equals 95% UCL divided by the RSL divided by the acceptable risk level.

[b] Corresponding Cancer Risk equals 95% UCL divided by the RSL divided by the acceptable risk level.

[c] Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

[d] Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05,

Constituents selected as COPCs are indicated by shading.

mg/kg = milligrams per kilogram

HI = Hazard Index

ProUCL, Version 4.1.00 used to determine distribution of data and calculate 95% UCL, following recommendations
in users guide (USEPA. May 2010. ProUCL, Version 4.1. Prepared by Lockheed Martin Environmental Services).
Options: 95% Adjusted Gamma UCL (95% Adj-G); Maximum detected concentration (Max); 95% Kaplan-Meier (Chebyshev) UCL (95% KM); Arithmetic Mean (Mean)

UCL Rationale:

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.

(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.

(3) Test indicates data are gamma distributed.

(4) Distribution tests are inconclusive

(5) Max value used because 95% UCL greater than max.

(6) Lead evaluated using arithmetic mean concentration in lead models, therefore, arithmetic mean concentration presented here.

TABLE 8-5

Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Sediment

Skeet and Trap Range

Dam Neck Annex

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening Toxicity Value [4]	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Sediment	120-12-7	Anthracene	2.8E-03 J	2.8E-03 J	MG/KG	DNSTR-SD01-0511	1/2	0.00783 - 0.00844	2.8E-03	N/A	1.7E+04 N	3.6E+02	SSL	NO	BSL
	56-55-3	Benzo(a)anthracene	8.2E-03	8.2E-03	MG/KG	DNSTR-SD01-0511	1/2	0.00783 - 0.00844	8.2E-03	N/A	1.5E+00 C	1.0E-02	SSL	NO	BSL
	50-32-8	Benzo(a)pyrene	9.3E-03	9.3E-03	MG/KG	DNSTR-SD01-0511	1/2	0.00783 - 0.00844	9.3E-03	N/A	1.5E-01 C	3.5E-03	SSL	NO	BSL
	205-99-2	Benzo(b)fluoranthene	1.1E-02	1.1E-02	MG/KG	DNSTR-SD01-0511	1/2	0.00783 - 0.00844	1.1E-02	N/A	1.5E+00 C	3.5E-02	SSL	NO	BSL
	191-24-2	Benzo(g,h,i)perylene	6.4E-03 J	6.4E-03 J	MG/KG	DNSTR-SD01-0511	1/2	0.00783 - 0.00844	6.4E-03	N/A	1.7E+03 N			NO	BSL
	218-01-9	Chrysene	9.3E-03	9.3E-03	MG/KG	DNSTR-SD01-0511	1/2	0.00783 - 0.00844	9.3E-03	N/A	1.5E+02 C	1.1E+00	SSL	NO	BSL
	206-44-0	Fluoranthene	2.3E-03 J	2.6E-02 J	MG/KG	DNSTR-SD01-0511	2/2	0.00783 - 0.00844	2.6E-02	N/A	2.3E+03 N	1.6E+02	SSL	NO	BSL
	193-39-5	Indeno(1,2,3-cd)pyrene	4.8E-03 J	4.8E-03 J	MG/KG	DNSTR-SD01-0511	1/2	0.00783 - 0.00844	4.8E-03	N/A	1.5E+00 C	1.2E-01	SSL	NO	BSL
	85-01-8	Phenanthrene	1.4E-02	1.4E-02	MG/KG	DNSTR-SD01-0511	1/2	0.00783 - 0.00844	1.4E-02	N/A	1.7E+04 N			NO	BSL
	129-00-0	Pyrene	1.9E-02 J	1.9E-02 J	MG/KG	DNSTR-SD01-0511	1/2	0.00783 - 0.00844	1.9E-02	N/A	1.7E+03 N	1.2E+02	SSL	NO	BSL
	7439-92-1	**Lead**	**6.5E+00**	**1.1E+03**	**MG/KG**	**DNSTR-SD09-0511**	**20/20**	**0.177 - 0.39**	**1.1E+03**	**N/A**	**4.0E+02 NL**			**YES**	**ASL**

Notes:

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). June , 2011. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. [Online].
Available: http://epa-prgs.ornl.gov/chemicals/index.shtml. Used ten times the adjusted (noncarcinogenic RSLs adjusted by dividing by 10) residential soil RSLs.
The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.
RSL value for Pyrene used as surrogate for Benzo(g,h,i)perylene.
RSL value for Anthracene used as surrogate for Phenanthrene.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered

SSL = Protection of groundwater risk-based SSL from RSL Table

C = Carcinogenic

N = Noncarcinogenic

N/A = Not available

NL = Noncarcinongenic lead residential soil RSL not adjusted by dividing by 10.

J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.

Table 8-6

Ecological Screening Statistics - Skeet and Trap Range Surface Soil - Plants and Soil Invertebrates

Fleet Combat Training Center - Dam Neck Annex

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL (Norm)	Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
PAHs (UG/KG)															
2-Methylnaphthalene	6.67 - 33.4	9 / 11	1.51	3,430	DNSTR-SS22-0511	545	1,047	1,117	LMW PAH	-- / --	--	YES	--	--	YES
Acenaphthene	-- - --	11 / 11	2.52	13,500	DNSTR-SS22-0511	2,451	4,268	4,783	LMW PAH	-- / --	--	YES	--	--	YES
Acenaphthylene	6.67 - 236	2 / 11	1.76	3.55	DNSTR-SS05-0610	43.9	46.9	69.5	LMW PAH	-- / --	--	YES	--	--	YES
Anthracene	6.67 - 33.4	9 / 11	7.96	54,000	DNSTR-SS22-0511	9,465	16,855	18,676	LMW PAH	-- / --	--	YES	--	--	YES
Benzo(a)anthracene	-- - --	11 / 11	73.6	302,000	DNSTR-SS22-0511	59,656	98,779	113,637	HMW PAH	-- / --	--	YES	--	--	YES
Benzo(a)pyrene	-- - --	11 / 11	84.1	279,000	DNSTR-SS22-0511	52,691	89,353	101,520	HMW PAH	-- / --	--	YES	--	--	YES
Benzo(b)fluoranthene	-- - --	11 / 11	113	329,000	DNSTR-SS22-0511	65,219	108,104	124,295	HMW PAH	-- / --	--	YES	--	--	YES
Benzo(g,h,i)perylene	-- - --	11 / 11	56.0	113,000	DNSTR-SS22-0511	23,875	38,407	44,864	HMW PAH	-- / --	--	YES	--	--	YES
Benzo(k)fluoranthene	-- - --	11 / 11	44.3	129,000	DNSTR-SS22-0511	25,740	42,782	49,119	HMW PAH	-- / --	--	YES	--	--	YES
Chrysene	-- - --	11 / 11	83.4	315,000	DNSTR-SS22-0511	64,196	105,018	121,586	HMW PAH	-- / --	--	YES	--	--	YES
Dibenz(a,h)anthracene	-- - --	11 / 11	13.5	31,800	DNSTR-SS22-0511	7,021	10,976	13,019	HMW PAH	-- / --	--	YES	--	--	YES
Fluoranthene	-- - --	11 / 11	108	545,000	DNSTR-SS22-0511	99,075	171,690	192,899	LMW PAH	-- / --	--	YES	--	--	YES
Fluorene	6.67 - 212	8 / 11	2.34	10,100	DNSTR-SS22-0511	1,635	3,236	3,403	LMW PAH	-- / --	--	YES	--	--	YES
Indeno(1,2,3-cd)pyrene	-- - --	11 / 11	62.0	102,000	DNSTR-SS22-0511	22,551	35,072	41,717	HMW PAH	-- / --	--	YES	--	--	YES
Naphthalene	2.66 - 4.96	8 / 11	16.3	8,200	DNSTR-SS22-0511	1,474	2,599	2,894	LMW PAH	-- / --	--	YES	--	--	YES
Phenanthrene	-- - --	11 / 11	30.4	253,000	DNSTR-SS22-0511	41,813	77,381	84,100	LMW PAH	-- / --	--	YES	--	--	YES
Pyrene	-- - --	11 / 11	99.7	466,000	DNSTR-SS22-0511	84,795	146,125	164,649	HMW PAH	-- / --	--	YES	--	--	YES
PAH (HMW)	-- - --	11 / 11	641	1,750,000	DNSTR-SS22-0511	340,429	566,894	650,224	18,000	6 / 11	97.2	YES	36.1	18.9	YES
PAH (LMW)	-- - --	11 / 11	157	1,204,118	DNSTR-SS22-0511	221,817	381,139	430,100	29,000	4 / 11	41.5	YES	14.8	7.65	YES
Inorganics (MG/KG)															
Lead	-- - --	21 / 21	33.3	13,600	DNSTR-SS12-0610	1,274	2,904	2,367	120	16 / 21	113	YES	19.7	10.6	YES

1 - Count of detected samples exceeding or equaling Screening Value

Table 8-7
Exceedances - Skeet and Trap Range Surface Soil - Plants and Soil Invertebrates
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Soil Screening Value	DNSTR-SO01	DNSTR-SO02	DNSTR-SO03	DNSTR-SO04	DNSTR-SO05
		DNSTR-SS01-0610	DNSTR-SS02-0610	DNSTR-SS03-0610	DNSTR-SS04-0610	DNSTR-SS05-0610
		06/17/10	06/17/10	06/17/10	06/17/10	06/17/10
PAHs (UG/KG)						
2-Methylnaphthalene	LMW PAH	14.1 J	10.1 J	24.4 J	33.4 U	1.51 J
Acenaphthene	LMW PAH	68.7	46.5	109	19.7 J	2.52 J
Acenaphthylene	LMW PAH	33.4 U	33.4 U	33.4 U	33.4 U	3.55 J
Anthracene	LMW PAH	210	166	382	33.4 U	7.96
Benzo(a)anthracene	HMW PAH	2,180	1,420	3,300	639	75.5
Benzo(a)pyrene	HMW PAH	2,480	1,700	3,520	801	84.1
Benzo(b)fluoranthene	HMW PAH	3,370	2,290	4,670	1,070	113
Benzo(g,h,i)perylene	HMW PAH	1,540	1,160	2,180	549	57.8
Benzo(k)fluoranthene	HMW PAH	1,160	834	1,680	410	44.3
Chrysene	HMW PAH	2,470	1,680	3,610	771	83.4
Dibenz(a,h)anthracene	HMW PAH	378	285	564	136	15.8
Fluoranthene	LMW PAH	3,330	2,160	4,900	942	108
Fluorene	LMW PAH	28.7 J	25.3 J	61.8	33.4 U	2.34 J
Indeno(1,2,3-cd)pyrene	HMW PAH	1,760	1,270	2,430	583	67.6
Naphthalene	LMW PAH	42.7	32.6 J	75.3	16.3 J	4.92 B
Phenanthrene	LMW PAH	953	715	1,680	291	33.9
Pyrene	HMW PAH	2,990	1,890	4,290	854	99.7
PAH (HMW)	18,000	18,328	12,529	26,244	5,813	641
PAH (LMW)	29,000	4,664	3,172	7,249	1,336	162
Inorganics (MG/KG)						
Lead	120	33.3	87.7	90.7	59.8	242

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections
NA - Not analyzed

Table 8-7
Exceedances - Skeet and Trap Range Surface Soil - Plants and Soil Invertebrates
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Soil Screening Value	DNSTR-SO06	DNSTR-SO07	DNSTR-SO08	DNSTR-SO09	DNSTR-SO10
		DNSTR-SS06-0610	DNSTR-SS07-0610	DNSTR-SS08-0610	DNSTR-SS09-0610	DNSTR-SS10-0610
		06/17/10	06/17/10	06/17/10	06/17/10	06/17/10
PAHs (UG/KG)						
2-Methylnaphthalene	LMW PAH	6.67 U	2.19 L	NA	NA	NA
Acenaphthene	LMW PAH	3.08 J	5.09 J	NA	NA	NA
Acenaphthylene	LMW PAH	1.76 J	6.67 U	NA	NA	NA
Anthracene	LMW PAH	6.67 U	33.5 L	NA	NA	NA
Benzo(a)anthracene	HMW PAH	73.6	133 L	NA	NA	NA
Benzo(a)pyrene	HMW PAH	87.4	127 L	NA	NA	NA
Benzo(b)fluoranthene	HMW PAH	117	177 L	NA	NA	NA
Benzo(g,h,i)perylene	HMW PAH	56	79.7 L	NA	NA	NA
Benzo(k)fluoranthene	HMW PAH	45.2	65.4 L	NA	NA	NA
Chrysene	HMW PAH	87.2	154 L	NA	NA	NA
Dibenz(a,h)anthracene	HMW PAH	13.5	21.2 L	NA	NA	NA
Fluoranthene	LMW PAH	110	271 L	NA	NA	NA
Fluorene	LMW PAH	6.67 U	5.72 J	NA	NA	NA
Indeno(1,2,3-cd)pyrene	HMW PAH	62	86.7	NA	NA	NA
Naphthalene	LMW PAH	2.66 B	4.96 B	NA	NA	NA
Phenanthrene	LMW PAH	30.4	143 L	NA	NA	NA
Pyrene	HMW PAH	100	218 L	NA	NA	NA
PAH (HMW)	18,000	642	1,062	NA	NA	NA
PAH (LMW)	29,000	157	466	NA	NA	NA
Inorganics (MG/KG)						
Lead	120	1,590	129	2,340	735	624

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections
NA - Not analyzed

Table 8-7

Exceedances - Skeet and Trap Range Surface Soil - Plants and Soil Invertebrates

Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Soil Screening Value	DNSTR-SO11 DNSTR-SS11-0610 06/17/10	DNSTR-SO12 DNSTR-SS12-0610 06/17/10	DNSTR-SO13 DNSTR-SS13-0610 06/17/10	DNSTR-SO14 DNSTR-SS14-0610 06/17/10	DNSTR-SO15 DNSTR-SS15-0610 06/17/10
PAHs (UG/KG)						
2-Methylnaphthalene	LMW PAH	NA	NA	NA	NA	NA
Acenaphthene	LMW PAH	NA	NA	NA	NA	NA
Acenaphthylene	LMW PAH	NA	NA	NA	NA	NA
Anthracene	LMW PAH	NA	NA	NA	NA	NA
Benzo(a)anthracene	HMW PAH	NA	NA	NA	NA	NA
Benzo(a)pyrene	HMW PAH	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	HMW PAH	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	HMW PAH	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	HMW PAH	NA	NA	NA	NA	NA
Chrysene	HMW PAH	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	HMW PAH	NA	NA	NA	NA	NA
Fluoranthene	LMW PAH	NA	NA	NA	NA	NA
Fluorene	LMW PAH	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	HMW PAH	NA	NA	NA	NA	NA
Naphthalene	LMW PAH	NA	NA	NA	NA	NA
Phenanthrene	LMW PAH	NA	NA	NA	NA	NA
Pyrene	HMW PAH	NA	NA	NA	NA	NA
PAH (HMW)	18,000	NA	NA	NA	NA	NA
PAH (LMW)	29,000	NA	NA	NA	NA	NA
Inorganics (MG/KG)						
Lead	120	1,810	13,600	536	1,760	311

Notes:

Grey highlighting indicates value greater than screening value

Bold indicates detections

NA - Not analyzed

Table 8-7
Exceedances - Skeet and Trap Range Surface Soil - Plants and Soil Invertebrates
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Soil Screening Value	DNSTR-SO16 DNSTR-SS16-0610 06/17/10	DNSTR-SO17 DNSTR-SS17-0610 06/17/10	DNSTR-SO18 DNSTR-SS18-0610 06/17/10	DNSTR-SO19 DNSTR-SS19-0610 06/17/10	DNSTR-SO20 DNSTR-SS20-0610 06/17/10
PAHs (UG/KG)						
2-Methylnaphthalene	LMW PAH	NA	NA	NA	NA	NA
Acenaphthene	LMW PAH	NA	NA	NA	NA	NA
Acenaphthylene	LMW PAH	NA	NA	NA	NA	NA
Anthracene	LMW PAH	NA	NA	NA	NA	NA
Benzo(a)anthracene	HMW PAH	NA	NA	NA	NA	NA
Benzo(a)pyrene	HMW PAH	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	HMW PAH	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	HMW PAH	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	HMW PAH	NA	NA	NA	NA	NA
Chrysene	HMW PAH	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	HMW PAH	NA	NA	NA	NA	NA
Fluoranthene	LMW PAH	NA	NA	NA	NA	NA
Fluorene	LMW PAH	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	HMW PAH	NA	NA	NA	NA	NA
Naphthalene	LMW PAH	NA	NA	NA	NA	NA
Phenanthrene	LMW PAH	NA	NA	NA	NA	NA
Pyrene	HMW PAH	NA	NA	NA	NA	NA
PAH (HMW)	18,000	NA	NA	NA	NA	NA
PAH (LMW)	29,000	NA	NA	NA	NA	NA
Inorganics (MG/KG)						
Lead	120	1,070	401	55.1	708	371

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections
NA - Not analyzed

Table 8-7
Exceedances - Skeet and Trap Range Surface Soil - Plants and Soil Invertebrates
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Soil Screening Value	DNSTR-SO21	DNSTR-SS22	DNSTR-SS23	DNSTR-SS24	DNSTR-SS25
		DNSTR-SS21-0610	DNSTR-SS22-0511	DNSTR-SS23-0511	DNSTR-SS24-0511	DNSTR-SS25-0511
		06/17/10	05/11/11	05/11/11	05/11/11	05/11/11
PAHs (UG/KG)						
2-Methylnaphthalene	LMW PAH	NA	3,430	610	1,340	543
Acenaphthene	LMW PAH	NA	13,500	4,270	6,440	2,500
Acenaphthylene	LMW PAH	NA	176 U	212 U	236 U	191 U
Anthracene	LMW PAH	NA	54,000	10,900	24,400	14,000
Benzo(a)anthracene	HMW PAH	NA	302,000	111,000	170,000	65,400
Benzo(a)pyrene	HMW PAH	NA	279,000	110,000	135,000	46,800
Benzo(b)fluoranthene	HMW PAH	NA	329,000	141,000	180,000	55,600
Benzo(g,h,i)perylene	HMW PAH	NA	113,000	54,400	70,000	19,600
Benzo(k)fluoranthene	HMW PAH	NA	129,000	53,500	75,000	21,400
Chrysene	HMW PAH	NA	315,000	126,000	190,000	66,300
Dibenz(a,h)anthracene	HMW PAH	NA	31,800	17,100	19,800	7,120
Fluoranthene	LMW PAH	NA	545,000	173,000	254,000	106,000
Fluorene	LMW PAH	NA	10,100	212 U	5,030	2,600
Indeno(1,2,3-cd)pyrene	HMW PAH	NA	102,000	54,900	63,200	21,700
Naphthalene	LMW PAH	NA	8,200	2,050	4,170	1,620
Phenanthrene	LMW PAH	NA	253,000	48,000	97,100	58,000
Pyrene	HMW PAH	NA	466,000	161,000	202,000	93,300
PAH (HMW)	18,000	NA	1,750,000	677,050	927,970	324,440
PAH (LMW)	29,000	NA	1,204,118	390,892	569,628	258,139
Inorganics (MG/KG)						
Lead	120	208	NA	NA	NA	NA

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections
NA - Not analyzed

Table 8-8
Screening Statistics - Skeet and Trap Range Surface Soil - Mammal/Bird Eco-SSLs
Fleet Combat Training Center - Dam Neck Annex

Chemical	Range of Non-Detect Values	Frequency of Detection	Maximum Concentration Detected	95% UCL (Norm)	Arithmetic Mean	Mammal Eco-SSL	Frequency of Exceedance	Maximum Hazard Quotient	95% UCL Hazard Quotient	Mean Hazard Quotient	Bird Eco-SSL	Frequency of Exceedance	Maximum Hazard Quotient	95% UCL Hazard Quotient	Mean Hazard Quotient
Inorganics (MG/KG)															
Lead	-- - --	21 / 21	13,600	2,367	1,274	56.0	19 / 21	243	42.3	22.8	11.0	21 / 21	1,236	215	116
PAHs (UG/KG)															
PAH (HMW)	-- - --	11 / 11	1,750,000	650,224	340,429	1,100	8 / 11	1,591	591	309	--	-- / --	--	--	--
PAH (LMW)	-- - --	11 / 11	1,204,118	430,100	221,817	100,000	4 / 11	12.0	4.30	2.22	--	-- / --	--	--	--

Shaded cells indicate HQ > 1

Table 8-9a
Summary of Meadow Vole Exposure Doses - Initial - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	13,600	1.522	a	2.07E+04	0.468	c	6.36E+03	0	7.05E+02	4.70	e	6.47	8.90	e	1.50E+02	1.09E+02	7.92E+01
PAHs																	
Acenaphthene	13.5	0.300	b	4.05E+00	Regresson	d1	4.14E-04	0	4.19E-02	65.6	f	147	328	f	6.39E-04	2.86E-04	1.28E-04
Acenaphthylene	0.0036	0.220	b	7.81E-04	Regresson	d2	3.68E-03	0	3.74E-04	65.6	f	147	328	f	5.69E-06	2.55E-06	1.14E-06
Anthracene	54.0	0.320	b	1.73E+01	Regresson	d3	8.30E+00	0	9.90E-01	65.6	f	147	328	f	1.51E-02	6.75E-03	3.02E-03
Benzo(a)anthracene	302	0.270	b	8.15E+01	Regresson	d4	1.99E+00	0	1.11E+00	0.62	f	1.37	3.07	f	1.81E+00	8.11E-01	3.63E-01
Benzo(a)pyrene	279	0.340	b	9.49E+01	Regresson	d5	3.08E+01	0	3.93E+00	0.62	f	1.37	3.07	f	6.40E+00	2.86E+00	1.28E+00
Benzo(b)fluoranthene	329	0.210	b	6.91E+01	0.310	d	1.02E+02	0	1.10E+01	0.62	f	1.37	3.07	f	1.79E+01	8.03E+00	3.59E+00
Benzo(g,h,i)perylene	113	0.150	b	1.70E+01	Regresson	d6	1.06E+02	0	1.08E+01	0.62	f	1.37	3.07	f	1.75E+01	7.83E+00	3.50E+00
Benzo(k)fluoranthene	129	0.210	b	2.71E+01	Regresson	d7	7.53E+00	0	1.12E+00	0.62	f	1.37	3.07	f	1.82E+00	8.15E-01	3.65E-01
Chrysene	315	0.440	b	1.39E+02	Regresson	d8	2.04E+00	0	1.27E+00	0.62	f	1.37	3.07	f	2.06E+00	9.23E-01	4.13E-01
Dibenz(a,h)anthracene	31.8	0.490	b	1.56E+01	0.130	d	4.13E+00	0	5.19E-01	0.62	f	1.37	3.07	f	8.45E-01	3.78E-01	1.69E-01
Fluoranthene	545	0.370	b	2.02E+02	0.500	d	2.73E+02	0	2.87E+01	65.6	f	147	328	f	4.37E-01	1.96E-01	8.75E-02
Fluorene	10.1	0.200	b	2.02E+00	Regresson	d9	5.31E-04	0	2.93E-02	65.6	f	147	328	f	4.46E-04	2.00E-04	8.92E-05
Indeno(1,2,3-cd)pyrene	102	0.410	b	4.18E+01	0.110	d	1.12E+01	0	1.45E+00	0.62	f	1.37	3.07	f	2.35E+00	1.05E+00	4.72E-01
Phenanthrene	253	0.280	b	7.08E+01	Regresson	d10	2.62E+01	0	3.36E+00	65.6	f	147	328	f	5.13E-02	2.29E-02	1.03E-02
Pyrene	466	0.390	b	1.82E+02	0.720	d	3.36E+02	0	3.47E+01	0.62	f	1.37	3.07	f	5.64E+01	2.52E+01	1.13E+01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0031 = Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.020 = Proportion of diet composed of food item (soil invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.956 = Proportion of diet composed of food item (terrestrial plants) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.024 = Proportion of diet composed of soil (Beyer et al. 1994)
WIR = 0.0133 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.030 = Body weight (kg) (Silva and Downing 1995)

a Sample et al. 1998a (90th percentile)
b Beyer and Stafford 1993 (median)
c Bechtel Jacobs 1998a (90th percentile)
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e USEPA 2005c
f USEPA 2007d

Table 8-9b

Summary of Meadow Vole Exposure Doses - Refined - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	1,274	Regression	a	2.58E+02	Regresson	c	1.46E+01	0	2.43E+00	4.70	e	6.47	8.90	e	5.17E-01	3.75E-01	2.73E-01
PAHs																	
Acenaphthene	2.45	0.300	b	7.35E-01	Regresson	d1	1.78E-03	0	3.67E-03	65.6	f	147	328	f	5.60E-05	2.50E-05	1.12E-05
Acenaphthylene	0.0439	0.220	b	9.66E-03	Regresson	d2	2.69E-02	0	1.32E-03	65.6	f	147	328	f	2.00E-05	8.97E-06	4.01E-06
Anthracene	9.47	0.320	b	3.03E+00	Regresson	d3	2.14E+00	0	1.14E-01	65.6	f	147	328	f	1.74E-03	7.77E-04	3.47E-04
Benzo(a)anthracene	59.7	0.270	b	1.61E+01	Regresson	d4	7.58E-01	0	1.21E-01	0.62	f	1.37	3.07	f	1.97E-01	8.80E-02	3.94E-02
Benzo(a)pyrene	52.7	0.340	b	1.79E+01	Regresson	d5	6.07E+00	0	3.63E-01	0.62	f	1.37	3.07	f	5.90E-01	2.64E-01	1.18E-01
Benzo(b)fluoranthene	65.2	0.210	b	1.37E+01	0.310	d	2.02E+01	0	1.03E+00	0.62	f	1.37	3.07	f	1.68E+00	7.52E-01	3.37E-01
Benzo(g,h,i)perylene	23.9	0.150	b	3.58E+00	Regresson	d6	1.68E+01	0	8.16E-01	0.62	f	1.37	3.07	f	1.33E+00	5.94E-01	2.66E-01
Benzo(k)fluoranthene	25.7	0.210	b	5.41E+00	Regresson	d7	1.88E+00	0	1.23E-01	0.62	f	1.37	3.07	f	2.01E-01	8.98E-02	4.02E-02
Chrysene	64.2	0.440	b	2.82E+01	Regresson	d8	7.91E-01	0	1.40E-01	0.62	f	1.37	3.07	f	2.27E-01	1.02E-01	4.55E-02
Dibenz(a,h)anthracene	7.02	0.490	b	3.44E+00	0.130	d	9.13E-01	0	5.42E-02	0.62	f	1.37	3.07	f	8.81E-02	3.94E-02	1.76E-02
Fluoranthene	99.1	0.370	b	3.67E+01	0.500	d	4.95E+01	0	2.46E+00	65.6	f	147	328	f	3.76E-02	1.68E-02	7.51E-03
Fluorene	1.63	0.200	b	3.27E-01	Regresson	d9	2.52E-03	0	2.35E-03	65.6	f	147	328	f	3.59E-05	1.60E-05	7.17E-06
Indeno(1,2,3-cd)pyrene	22.6	0.410	b	9.25E+00	0.110	d	2.48E+00	0	1.51E-01	0.62	f	1.37	3.07	f	2.46E-01	1.10E-01	4.93E-02
Phenanthrene	41.8	0.280	b	1.17E+01	Regresson	d10	8.58E+00	0	4.61E-01	65.6	f	147	328	f	7.02E-03	3.14E-03	1.40E-03
Pyrene	84.8	0.390	b	3.31E+01	0.720	d	6.11E+01	0	2.98E+00	0.62	f	1.37	3.07	f	4.85E+00	2.17E+00	9.71E-01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI =	Chemical-specific	= Dietary intake for chemical (mg chemical/kg body weight/day)
FIR =	0.0021	= Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi =	Chemical-specific	= Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi =	0.020	= Proportion of diet composed of food item (soil invertebrates) (USEPA 1993a)
FCxi =	Chemical-specific	= Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi =	0.956	= Proportion of diet composed of food item (terrestrial plants) (USEPA 1993a)
SCx =	Chemical-specific	= Concentration of chemical in soil (mg/kg, dry weight)
PDS =	0.024	= Proportion of diet composed of soil (Beyer et al. 1994)
WIR =	0.0090	= Water ingestion rate (L/day) (USEPA 1993a)
WC =	Chemical-specific	= Concentration of chemical in water (mg/L)
BW =	0.0428	= Body weight (kg) (Silva and Downing 1995)

a Sample et al. 1998a

$C_w = e^{(-0.218 + 0.807(\ln Cs))}$

b Beyer and Stafford 1993 (median)

c Bechtel Jacobs 1998a

$C_n = e^{(-1.328 + 0.561(\ln Cs))}$

d USEPA 2007e

1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$

3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$

4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$

6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$

7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$

8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$

e USEPA 2005c

f USEPA 2007d

Table 8-10a

Summary of Mourning Dove Exposure Doses - Initial - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	13,600	1.522	a	2.07E+04	0.468	c	6.36E+03	0	1.34E+03	1.13	e	3.57	11.3	e	1.18E+03	3.75E+02	1.18E+02
PAHs																	
Acenaphthene	13.5	0.300	b	4.05E+00	Regresson	d1	4.14E-04	0	1.34E-01	7.10	g	15.9	35.5	f	1.89E-02	8.47E-03	3.79E-03
Acenaphthylene	0.0036	0.220	b	7.81E-04	Regresson	d2	3.68E-03	0	7.31E-04	7.10	g	15.9	35.5	f	1.03E-04	4.60E-05	2.06E-05
Anthracene	54.0	0.320	b	1.73E+01	Regresson	d3	8.30E+00	0	2.11E+00	7.10	g	15.9	35.5	f	2.97E-01	1.33E-01	5.94E-02
Benzo(a)anthracene	302	0.270	b	8.15E+01	Regresson	d4	1.99E+00	0	3.38E+00	7.10	g	15.9	35.5	f	4.76E-01	2.13E-01	9.53E-02
Benzo(a)pyrene	279	0.340	b	9.49E+01	Regresson	d5	3.08E+01	0	8.61E+00	7.10	g	15.9	35.5	f	1.21E+00	5.42E-01	2.43E-01
Benzo(b)fluoranthene	329	0.210	b	6.91E+01	0.310	d	1.02E+02	0	2.26E+01	7.10	g	15.9	35.5	f	3.18E+00	1.42E+00	6.36E-01
Benzo(g,h,i)perylene	113	0.150	b	1.70E+01	Regresson	d6	1.06E+02	0	2.11E+01	7.10	g	15.9	35.5	f	2.97E+00	1.33E+00	5.95E-01
Benzo(k)fluoranthene	129	0.210	b	2.71E+01	Regresson	d7	7.53E+00	0	2.71E+00	7.10	g	15.9	35.5	f	3.81E-01	1.71E-01	7.63E-02
Chrysene	315	0.440	b	1.39E+02	Regresson	d8	2.04E+00	0	3.52E+00	7.10	g	15.9	35.5	f	4.96E-01	2.22E-01	9.92E-02
Dibenz(a,h)anthracene	31.8	0.490	b	1.56E+01	0.130	d	4.13E+00	0	1.10E+00	7.10	g	15.9	35.5	f	1.55E-01	6.92E-02	3.09E-02
Fluoranthene	545	0.370	b	2.02E+02	0.500	d	2.73E+02	0	5.70E+01	7.10	g	15.9	35.5	f	8.02E+00	3.59E+00	1.60E+00
Fluorene	10.1	0.200	b	2.02E+00	Regresson	d9	5.31E-04	0	1.01E-01	7.10	g	15.9	35.5	f	1.42E-02	6.34E-03	2.83E-03
Indeno(1,2,3-cd)pyrene	102	0.410	b	4.18E+01	0.110	d	1.12E+01	0	3.14E+00	7.10	g	15.9	35.5	f	4.42E-01	1.98E-01	8.84E-02
Phenanthrene	253	0.280	b	7.08E+01	Regresson	d10	2.62E+01	0	7.47E+00	7.10	g	15.9	35.5	f	1.05E+00	4.71E-01	2.11E-01
Pyrene	466	0.390	b	1.82E+02	0.720	d	3.36E+02	0	6.81E+01	7.10	g	15.9	35.5	f	9.59E+00	4.29E+00	1.92E+00

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)

FIR = 0.0209 = Food ingestion rate (kg/day dry weight) (Nagy 2001)

FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)

PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)

FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)

PDFi = 0.950 = Proportion of diet composed of food item (terrestrial plants) (Tomlinson et al. 1994)

SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)

PDS = 0.050 = Proportion of diet composed of soil (assumed based upon diet)

WIR = 0.0175 = Water ingestion rate (L/day) (USEPA 1993a)

WC = Chemical-specific = Concentration of chemical in water (mg/L)

BW = 0.105 = Body weight (kg) (Tomlinson et al. 1994)

a Sample et al. 1998a (90th percentile)

b Beyer and Stafford 1993 (median)

c Bechtel Jacobs 1998a (90th percentile)

d USEPA 2007e

1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$

3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$

4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$

6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$

7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$

8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$

e Sample et al. 1996

f NOAEL multiplied by 5

g Rigdon and Neal 1963

Table 8-10b

Summary of Mourning Dove Exposure Doses - Refined - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	1,274	Regression	a	2.58E+02	Regresson	c	1.46E+01	0	1.08E+01	1.13	e	3.57	11.3	e	9.54E+00	3.02E+00	9.54E-01
PAHs																	
Acenaphthene	2.45	0.300	b	7.35E-01	Regresson	d1	1.78E-03	0	1.73E-02	7.10	g	15.9	35.5	f	2.43E-03	1.09E-03	4.86E-04
Acenaphthylene	0.0439	0.220	b	9.66E-03	Regresson	d2	2.69E-02	0	3.85E-03	7.10	g	15.9	35.5	f	5.42E-04	2.43E-04	1.08E-04
Anthracene	9.47	0.320	b	3.03E+00	Regresson	d3	2.14E+00	0	3.48E-01	7.10	g	15.9	35.5	f	4.90E-02	2.19E-02	9.81E-03
Benzo(a)anthracene	59.7	0.270	b	1.61E+01	Regresson	d4	7.58E-01	0	5.14E-01	7.10	g	15.9	35.5	f	7.24E-02	3.24E-02	1.45E-02
Benzo(a)pyrene	52.7	0.340	b	1.79E+01	Regresson	d5	6.07E+00	0	1.17E+00	7.10	g	15.9	35.5	f	1.64E-01	7.35E-02	3.29E-02
Benzo(b)fluoranthene	65.2	0.210	b	1.37E+01	0.310	d	2.02E+01	0	3.12E+00	7.10	g	15.9	35.5	f	4.40E-01	1.97E-01	8.79E-02
Benzo(g,h,i)perylene	23.9	0.150	b	3.58E+00	Regresson	d6	1.68E+01	0	2.38E+00	7.10	g	15.9	35.5	f	3.36E-01	1.50E-01	6.71E-02
Benzo(k)fluoranthene	25.7	0.210	b	5.41E+00	Regresson	d7	1.88E+00	0	4.27E-01	7.10	g	15.9	35.5	f	6.02E-02	2.69E-02	1.20E-02
Chrysene	64.2	0.440	b	2.82E+01	Regresson	d8	7.91E-01	0	5.50E-01	7.10	g	15.9	35.5	f	7.75E-02	3.47E-02	1.55E-02
Dibenz(a,h)anthracene	7.02	0.490	b	3.44E+00	0.130	d	9.13E-01	0	1.69E-01	7.10	g	15.9	35.5	f	2.38E-02	1.07E-02	4.77E-03
Fluoranthene	99.1	0.370	b	3.67E+01	0.500	d	4.95E+01	0	7.22E+00	7.10	g	15.9	35.5	f	1.02E+00	4.55E-01	2.03E-01
Fluorene	1.63	0.200	b	3.27E-01	Regresson	d9	2.52E-03	0	1.17E-02	7.10	g	15.9	35.5	f	1.65E-03	7.36E-04	3.29E-04
Indeno(1,2,3-cd)pyrene	22.6	0.410	b	9.25E+00	0.110	d	2.48E+00	0	4.84E-01	7.10	g	15.9	35.5	f	6.82E-02	3.05E-02	1.36E-02
Phenanthrene	41.8	0.280	b	1.17E+01	Regresson	d10	8.58E+00	0	1.42E+00	7.10	g	15.9	35.5	f	2.00E-01	8.96E-02	4.01E-02
Pyrene	84.8	0.390	b	3.31E+01	0.720	d	6.11E+01	0	8.64E+00	7.10	g	15.9	35.5	f	1.22E+00	5.44E-01	2.43E-01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)

FIR = 0.0176 = Food ingestion rate (kg/day dry weight) (Nagy 2001)

FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)

PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates)

FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)

PDFi = 0.950 = Proportion of diet composed of food item (terrestrial plants) (Tomlinson et al. 1994)

SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)

PDS = 0.050 = Proportion of diet composed of soil (assumed based upon diet)

WIR = 0.0148 = Water ingestion rate (L/day) (USEPA 1993a)

WC = Chemical-specific = Concentration of chemical in water (mg/L)

BW = 0.1265 = Body weight (kg) (Tomlinson et al. 1994)

a Sample et al. 1998a
$C_w = e^{(-0.218 + 0.807(\ln Cs))}$

b Beyer and Stafford 1993 (median)

c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln Cs))}$

d USEPA 2007e

1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$

3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$

4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$

6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$

7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$

8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$

e Sample et al. 1996

f NOAEL multiplied by 5

g Rigdon and Neal 1963

Table 8-11a
Summary of Short-tailed Shrew Exposure Doses - Initial - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	13,600	1.522	a	2.07E+04	0.468	c	6.36E+03	0	2.71E+03	4.70	e	6.47	8.90	e	5.76E+02	4.19E+02	3.04E+02
PAHs																	
Acenaphthene	13.5	0.300	b	4.05E+00	Regresson	d1	4.14E-04	0	7.21E-01	65.6	f	147	328	f	1.10E-02	4.91E-03	2.20E-03
Acenaphthylene	0.0036	0.220	b	7.81E-04	Regresson	d2	3.68E-03	0	1.81E-04	65.6	f	147	328	f	2.76E-06	1.23E-06	5.52E-07
Anthracene	54.0	0.320	b	1.73E+01	Regresson	d3	8.30E+00	0	3.07E+00	65.6	f	147	328	f	4.67E-02	2.09E-02	9.34E-03
Benzo(a)anthracene	302	0.270	b	8.15E+01	Regresson	d4	1.99E+00	0	1.51E+01	0.62	f	1.37	3.07	f	2.45E+01	1.10E+01	4.91E+00
Benzo(a)pyrene	279	0.340	b	9.49E+01	Regresson	d5	3.08E+01	0	1.64E+01	0.62	f	1.37	3.07	f	2.67E+01	1.19E+01	5.34E+00
Benzo(b)fluoranthene	329	0.210	b	6.91E+01	0.310	d	1.02E+02	0	1.48E+01	0.62	f	1.37	3.07	f	2.41E+01	1.08E+01	4.82E+00
Benzo(g,h,i)perylene	113	0.150	b	1.70E+01	Regresson	d6	1.06E+02	0	4.76E+00	0.62	f	1.37	3.07	f	7.74E+00	3.47E+00	1.55E+00
Benzo(k)fluoranthene	129	0.210	b	2.71E+01	Regresson	d7	7.53E+00	0	5.59E+00	0.62	f	1.37	3.07	f	9.08E+00	4.06E+00	1.82E+00
Chrysene	315	0.440	b	1.39E+02	Regresson	d8	2.04E+00	0	2.20E+01	0.62	f	1.37	3.07	f	3.57E+01	1.60E+01	7.16E+00
Dibenz(a,h)anthracene	31.8	0.490	b	1.56E+01	0.130	d	4.13E+00	0	2.43E+00	0.62	f	1.37	3.07	f	3.95E+00	1.77E+00	7.92E-01
Fluoranthene	545	0.370	b	2.02E+02	0.500	d	2.73E+02	0	3.54E+01	65.6	f	147	328	f	5.39E-01	2.41E-01	1.08E-01
Fluorene	10.1	0.200	b	2.02E+00	Regresson	d9	5.31E-04	0	4.22E-01	65.6	f	147	328	f	6.43E-03	2.87E-03	1.29E-03
Indeno(1,2,3-cd)pyrene	102	0.410	b	4.18E+01	0.110	d	1.12E+01	0	6.83E+00	0.62	f	1.37	3.07	f	1.11E+01	4.97E+00	2.22E+00
Phenanthrene	253	0.280	b	7.08E+01	Regresson	d10	2.62E+01	0	1.31E+01	65.6	f	147	328	f	2.00E-01	8.93E-02	3.99E-02
Pyrene	466	0.390	b	1.82E+02	0.720	d	3.36E+02	0	3.20E+01	0.62	f	1.37	3.07	f	5.21E+01	2.33E+01	1.04E+01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI =	Chemical-specific	= Dietary intake for chemical (mg chemical/kg body weight/day)
FIR =	0.0019	= Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi =	Chemical-specific	= Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi =	0.823	= Proportion of diet composed of food item (soil invertebrates) (Sample and Suter 1994)
FCxi =	Chemical-specific	= Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi =	0.047	= Proportion of diet composed of food item (terrestrial plants) (Sample and Suter 1994)
SCx =	Chemical-specific	= Concentration of chemical in soil (mg/kg, dry weight)
PDS =	0.130	= Proportion of diet composed of soil (Sample and Suter 1994)
WIR =	0.0048	= Water ingestion rate (L/day) (USEPA 1993a)
WC =	Chemical-specific	= Concentration of chemical in water (mg/L)
BW =	0.01331	= Body weight (kg) (USEPA 1993a)

a Sample et al. 1998a (90th percentile)
b Beyer and Stafford 1993 (median)
c Bechtel Jacobs 1998a (90th percentile)
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e USEPA 2005c
f USEPA 2007d

Table 8-11b
Summary of Short-tailed Shrew Exposure Doses - Refined - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	1,274	Regression	a	2.58E+02	Regresson	c	1.46E+01	0	3.35E+01	4.70	e	6.47	8.90	e	7.13E+00	5.18E+00	3.76E+00
PAHs																	
Acenaphthene	2.45	0.300	b	7.35E-01	Regresson	d1	1.78E-03	0	8.18E-02	65.6	f	147	328	f	1.25E-03	5.57E-04	2.49E-04
Acenaphthylene	0.0439	0.220	b	9.66E-03	Regresson	d2	2.69E-02	0	1.32E-03	65.6	f	147	328	f	2.01E-05	9.00E-06	4.03E-06
Anthracene	9.47	0.320	b	3.03E+00	Regresson	d3	2.14E+00	0	3.38E-01	65.6	f	147	328	f	5.16E-03	2.31E-03	1.03E-03
Benzo(a)anthracene	59.7	0.270	b	1.61E+01	Regresson	d4	7.58E-01	0	1.86E+00	0.62	f	1.37	3.07	f	3.03E+00	1.36E+00	6.07E-01
Benzo(a)pyrene	52.7	0.340	b	1.79E+01	Regresson	d5	6.07E+00	0	1.94E+00	0.62	f	1.37	3.07	f	3.15E+00	1.41E+00	6.31E-01
Benzo(b)fluoranthene	65.2	0.210	b	1.37E+01	0.310	d	2.02E+01	0	1.83E+00	0.62	f	1.37	3.07	f	2.98E+00	1.33E+00	5.97E-01
Benzo(g,h,i)perylene	23.9	0.150	b	3.58E+00	Regresson	d6	1.68E+01	0	6.05E-01	0.62	f	1.37	3.07	f	9.84E-01	4.41E-01	1.97E-01
Benzo(k)fluoranthene	25.7	0.210	b	5.41E+00	Regresson	d7	1.88E+00	0	6.98E-01	0.62	f	1.37	3.07	f	1.13E+00	5.08E-01	2.27E-01
Chrysene	64.2	0.440	b	2.82E+01	Regresson	d8	7.91E-01	0	2.80E+00	0.62	f	1.37	3.07	f	4.55E+00	2.04E+00	9.12E-01
Dibenz(a,h)anthracene	7.02	0.490	b	3.44E+00	0.130	d	9.13E-01	0	3.35E-01	0.62	f	1.37	3.07	f	5.45E-01	2.44E-01	1.09E-01
Fluoranthene	99.1	0.370	b	3.67E+01	0.500	d	4.95E+01	0	4.02E+00	65.6	f	147	328	f	6.12E-02	2.74E-02	1.22E-02
Fluorene	1.63	0.200	b	3.27E-01	Regresson	d9	2.52E-03	0	4.26E-02	65.6	f	147	328	f	6.50E-04	2.91E-04	1.30E-04
Indeno(1,2,3-cd)pyrene	22.6	0.410	b	9.25E+00	0.110	d	2.48E+00	0	9.43E-01	0.62	f	1.37	3.07	f	1.53E+00	6.86E-01	3.07E-01
Phenanthrene	41.8	0.280	b	1.17E+01	Regresson	d10	8.58E+00	0	1.37E+00	65.6	f	147	328	f	2.09E-02	9.34E-03	4.18E-03
Pyrene	84.8	0.390	b	3.31E+01	0.720	d	6.11E+01	0	3.64E+00	0.62	f	1.37	3.07	f	5.92E+00	2.65E+00	1.19E+00

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0015 = Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.823 = Proportion of diet composed of food item (soil invertebrates) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.047 = Proportion of diet composed of food item (terrestrial plants) (Sample and Suter 1994)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.130 = Proportion of diet composed of soil (Sample and Suter 1994)
WIR = 0.0038 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.01687 = Body weight (kg) (USEPA 1993a)

a Sample et al. 1998a
$C_w = e^{(-0.218 + 0.807(\ln Cs))}$
b Beyer and Stafford 1993 (median)
c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln Cs))}$
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e USEPA 2005c
f USEPA 2007d

Table 8-12a
Summary of American Robin Exposure Doses - Initial - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	13,600	1.522	a	2.07E+04	0.468	c	6.36E+03	0	1.50E+03	3.85	e	8.61	19.3	f	3.89E+02	1.74E+02	7.79E+01
PAHs																	
Acenaphthene	13.5	0.300	b	4.05E+00	Regresson	d1	4.14E-04	0	2.76E-01	7.10	g	15.9	35.5	f	3.89E-02	1.74E-02	7.78E-03
Acenaphthylene	0.0036	0.220	b	7.81E-04	Regresson	d2	3.68E-03	0	2.79E-04	7.10	g	15.9	35.5	f	3.94E-05	1.76E-05	7.87E-06
Anthracene	54.0	0.320	b	1.73E+01	Regresson	d3	8.30E+00	0	1.66E+00	7.10	g	15.9	35.5	f	2.34E-01	1.04E-01	4.67E-02
Benzo(a)anthracene	302	0.270	b	8.15E+01	Regresson	d4	1.99E+00	0	5.84E+00	7.10	g	15.9	35.5	f	8.23E-01	3.68E-01	1.65E-01
Benzo(a)pyrene	279	0.340	b	9.49E+01	Regresson	d5	3.08E+01	0	8.13E+00	7.10	g	15.9	35.5	f	1.14E+00	5.12E-01	2.29E-01
Benzo(b)fluoranthene	329	0.210	b	6.91E+01	0.310	d	1.02E+02	0	1.14E+01	7.10	g	15.9	35.5	f	1.60E+00	7.16E-01	3.20E-01
Benzo(g,h,i)perylene	113	0.150	b	1.70E+01	Regresson	d6	1.06E+02	0	7.82E+00	7.10	g	15.9	35.5	f	1.10E+00	4.92E-01	2.20E-01
Benzo(k)fluoranthene	129	0.210	b	2.71E+01	Regresson	d7	7.53E+00	0	2.51E+00	7.10	g	15.9	35.5	f	3.53E-01	1.58E-01	7.06E-02
Chrysene	315	0.440	b	1.39E+02	Regresson	d8	2.04E+00	0	8.79E+00	7.10	g	15.9	35.5	f	1.24E+00	5.54E-01	2.48E-01
Dibenz(a,h)anthracene	31.8	0.490	b	1.56E+01	0.130	d	4.13E+00	0	1.20E+00	7.10	g	15.9	35.5	f	1.70E-01	7.58E-02	3.39E-02
Fluoranthene	545	0.370	b	2.02E+02	0.500	d	2.73E+02	0	2.95E+01	7.10	g	15.9	35.5	f	4.15E+00	1.86E+00	8.30E-01
Fluorene	10.1	0.200	b	2.02E+00	Regresson	d9	5.31E-04	0	1.56E-01	7.10	g	15.9	35.5	f	2.19E-02	9.81E-03	4.39E-03
Indeno(1,2,3-cd)pyrene	102	0.410	b	4.18E+01	0.110	d	1.12E+01	0	3.33E+00	7.10	g	15.9	35.5	f	4.69E-01	2.10E-01	9.37E-02
Phenanthrene	253	0.280	b	7.08E+01	Regresson	d10	2.62E+01	0	6.50E+00	7.10	g	15.9	35.5	f	9.15E-01	4.09E-01	1.83E-01
Pyrene	466	0.390	b	1.82E+02	0.720	d	3.36E+02	0	3.18E+01	7.10	g	15.9	35.5	f	4.48E+00	2.00E+00	8.97E-01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0074 = Food ingestion rate (kg/day dry weight) (Levey and Karasov 1989)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.435 = Proportion of diet composed of food item (soil invertebrates) (Martin et al. 1951)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.519 = Proportion of diet composed of food item (terrestrial plants) (Martin et al. 1951)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.046 = Proportion of diet composed of soil (Sample and Suter 1994)
WIR = 0.0129 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.0635 = Body weight (kg) (USEPA 1993a)

a Sample et al. 1998a (90th percentile)
b Beyer and Stafford 1993 (median)
c Bechtel Jacobs 1998a (90th percentile)
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Sample et al. 1996
f NOAEL multiplied by 5
g Rigdon and Neal 1963

Table 8-12b

Summary of American Robin Exposure Doses - Refined - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																	
Lead	1,274	Regression	a	2.58E+02	Regresson	c	1.46E+01	0	1.27E+01	3.85	e	8.61	19.3	f	3.31E+00	1.48E+00	6.62E-01
PAHs																	
Acenaphthene	2.45	0.300	b	7.35E-01	Regresson	d1	1.78E-03	0	3.10E-02	7.10	g	15.9	35.5	f	4.36E-03	1.95E-03	8.73E-04
Acenaphthylene	0.0439	0.220	b	9.66E-03	Regresson	d2	2.69E-02	0	1.44E-03	7.10	g	15.9	35.5	f	2.03E-04	9.08E-05	4.06E-05
Anthracene	9.47	0.320	b	3.03E+00	Regresson	d3	2.14E+00	0	2.05E-01	7.10	g	15.9	35.5	f	2.88E-02	1.29E-02	5.76E-03
Benzo(a)anthracene	59.7	0.270	b	1.61E+01	Regresson	d4	7.58E-01	0	7.25E-01	7.10	g	15.9	35.5	f	1.02E-01	4.57E-02	2.04E-02
Benzo(a)pyrene	52.7	0.340	b	1.79E+01	Regresson	d5	6.07E+00	0	9.55E-01	7.10	g	15.9	35.5	f	1.35E-01	6.02E-02	2.69E-02
Benzo(b)fluoranthene	65.2	0.210	b	1.37E+01	0.310	d	2.02E+01	0	1.39E+00	7.10	g	15.9	35.5	f	1.96E-01	8.75E-02	3.92E-02
Benzo(g,h,i)perylene	23.9	0.150	b	3.58E+00	Regresson	d6	1.68E+01	0	8.13E-01	7.10	g	15.9	35.5	f	1.15E-01	5.12E-02	2.29E-02
Benzo(k)fluoranthene	25.7	0.210	b	5.41E+00	Regresson	d7	1.88E+00	0	3.23E-01	7.10	g	15.9	35.5	f	4.54E-02	2.03E-02	9.09E-03
Chrysene	64.2	0.440	b	2.82E+01	Regresson	d8	7.91E-01	0	1.12E+00	7.10	g	15.9	35.5	f	1.58E-01	7.04E-02	3.15E-02
Dibenz(a,h)anthracene	7.02	0.490	b	3.44E+00	0.130	d	9.13E-01	0	1.64E-01	7.10	g	15.9	35.5	f	2.31E-02	1.03E-02	4.62E-03
Fluoranthene	99.1	0.370	b	3.67E+01	0.500	d	4.95E+01	0	3.30E+00	7.10	g	15.9	35.5	f	4.65E-01	2.08E-01	9.30E-02
Fluorene	1.63	0.200	b	3.27E-01	Regresson	d9	2.52E-03	0	1.56E-02	7.10	g	15.9	35.5	f	2.20E-03	9.84E-04	4.40E-04
Indeno(1,2,3-cd)pyrene	22.6	0.410	b	9.25E+00	0.110	d	2.48E+00	0	4.54E-01	7.10	g	15.9	35.5	f	6.39E-02	2.86E-02	1.28E-02
Phenanthrene	41.8	0.280	b	1.17E+01	Regresson	d10	8.58E+00	0	8.19E-01	7.10	g	15.9	35.5	f	1.15E-01	5.16E-02	2.31E-02
Pyrene	84.8	0.390	b	3.31E+01	0.720	d	6.11E+01	0	3.57E+00	7.10	g	15.9	35.5	f	5.03E-01	2.25E-01	1.01E-01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI =	Chemical-specific	= Dietary intake for chemical (mg chemical/kg body weight/day)
FIR =	0.0055	= Food ingestion rate (kg/day dry weight) (Levey and Karasov 1989)
FCxi =	Chemical-specific	= Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi =	0.435	= Proportion of diet composed of food item (soil invertebrates) (Martin et al. 1951)
FCxi =	Chemical-specific	= Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi =	0.519	= Proportion of diet composed of food item (terrestrial plants) (Martin et al. 1951)
SCx =	Chemical-specific	= Concentration of chemical in soil (mg/kg, dry weight)
PDS =	0.046	= Proportion of diet composed of soil (Sample and Suter 1994)
WIR =	0.0106	= Water ingestion rate (L/day) (USEPA 1993a)
WC =	Chemical-specific	= Concentration of chemical in water (mg/L)
BW =	0.0773	= Body weight (kg) (USEPA 1993a)

a Sample et al. 1998a

$C_w = e^{(-0.218 + 0.807(\ln Cs))}$

b Beyer and Stafford 1993 (median)

c Bechtel Jacobs 1998a

$C_n = e^{(-1.328 + 0.561(\ln Cs))}$

d USEPA 2007e

1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$

3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$

4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$

6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$

7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$

8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$

e Sample et al. 1996

f NOAEL multiplied by 5

g Rigdon and Neal 1963

Table 8-13a
Summary of Red Fox Exposure Doses - Initial - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Soil-Mammal BAF		Small Mammal Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	13,600	1.522	a	2.07E+04	0.468	c	6.36E+03	0.286	e	3.89E+03	0	2.24E+02	4.70	f	6.47	8.90	f	4.76E+01	3.46E+01	2.51E+01
PAHs																				
Acenaphthene	13.5	0.300	b	4.05E+00	Regresson	d1	4.14E-04	0.000	d	0.00E+00	0	2.29E-02	65.6	g	147	328	g	3.49E-04	1.56E-04	6.98E-05
Acenaphthylene	0.0036	0.220	b	7.81E-04	Regresson	d2	3.68E-03	0.000	d	0.00E+00	0	1.76E-05	65.6	g	147	328	g	2.69E-07	1.20E-07	5.38E-08
Anthracene	54.0	0.320	b	1.73E+01	Regresson	d3	8.30E+00	0.000	d	0.00E+00	0	1.20E-01	65.6	g	147	328	g	1.83E-03	8.18E-04	3.66E-04
Benzo(a)anthracene	302	0.270	b	8.15E+01	Regresson	d4	1.99E+00	0.000	d	0.00E+00	0	5.07E-01	0.62	g	1.37	3.07	g	8.24E-01	3.69E-01	1.65E-01
Benzo(a)pyrene	279	0.340	b	9.49E+01	Regresson	d5	3.08E+01	0.000	d	0.00E+00	0	5.88E-01	0.62	g	1.37	3.07	g	9.56E-01	4.28E-01	1.92E-01
Benzo(b)fluoranthene	329	0.210	b	6.91E+01	0.310	d	1.02E+02	0.000	d	0.00E+00	0	8.52E-01	0.62	g	1.37	3.07	g	1.38E+00	6.20E-01	2.77E-01
Benzo(g,h,i)perylene	113	0.150	b	1.70E+01	Regresson	d6	1.06E+02	0.000	d	0.00E+00	0	5.14E-01	0.62	g	1.37	3.07	g	8.36E-01	3.74E-01	1.67E-01
Benzo(k)fluoranthene	129	0.210	b	2.71E+01	Regresson	d7	7.53E+00	0.000	d	0.00E+00	0	2.28E-01	0.62	g	1.37	3.07	g	3.71E-01	1.66E-01	7.43E-02
Chrysene	315	0.440	b	1.39E+02	Regresson	d8	2.04E+00	0.000	d	0.00E+00	0	5.98E-01	0.62	g	1.37	3.07	g	9.73E-01	4.35E-01	1.95E-01
Dibenz(a,h)anthracene	31.8	0.490	b	1.56E+01	0.130	d	4.13E+00	0.000	d	0.00E+00	0	7.53E-02	0.62	g	1.37	3.07	g	1.22E-01	5.48E-02	2.45E-02
Fluoranthene	545	0.370	b	2.02E+02	0.500	d	2.73E+02	0.000	d	0.00E+00	0	1.86E+00	65.6	g	147	328	g	2.84E-02	1.27E-02	5.68E-03
Fluorene	10.1	0.200	b	2.02E+00	Regresson	d9	5.31E-04	0.000	d	0.00E+00	0	1.58E-02	65.6	g	147	328	g	2.41E-04	1.08E-04	4.82E-05
Indeno(1,2,3-cd)pyrene	102	0.410	b	4.18E+01	0.110	d	1.12E+01	0.000	d	0.00E+00	0	2.24E-01	0.62	g	1.37	3.07	g	3.64E-01	1.63E-01	7.30E-02
Phenanthrene	253	0.280	b	7.08E+01	Regresson	d10	2.62E+01	0.000	d	0.00E+00	0	5.08E-01	65.6	g	147	328	g	7.74E-03	3.46E-03	1.55E-03
Pyrene	466	0.390	b	1.82E+02	0.720	d	3.36E+02	0.000	d	0.00E+00	0	1.94E+00	0.62	g	1.37	3.07	g	3.15E+00	1.41E+00	6.31E-01

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.1476 = Food ingestion rate (kg/day dry weight) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.028 = Proportion of diet composed of food item (soil invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.070 = Proportion of diet composed of food item (terrestrial plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (small mammals, dry weight basis)
PDFi = 0.874 = Proportion of diet composed of food item (small mammals) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.028 = Proportion of diet composed of soil (Beyer et al. 1994)
WIR = 0.4115 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 3.17 = Body weight (kg) (Silva and Downing 1995)

a Sample et al. 1998a (90th percentile)
b Beyer and Stafford 1993 (median)
c Bechtel Jacobs 1998a (90th percentile)
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Sample et al. 1998b (90th percentile - omnivore)
f USEPA 2005c
g USEPA 2007d

Table 8-13b
Summary of Red Fox Exposure Doses - Refined - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Soil-Mammal BAF		Small Mammal Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	1,274	Regression	a	2.58E+02	Regresson	c	1.46E+01	Regresson	e	2.55E+01	0	2.01E+00	4.70	f	6.47	8.90	f	4.27E-01	3.10E-01	2.25E-01
PAHs																				
Acenaphthene	2.45	0.300	b	7.35E-01	Regresson	d1	1.78E-03	0.000	d	0.00E+00	0	2.71E-03	65.6	g	147	328	g	4.13E-05	1.85E-05	8.26E-06
Acenaphthylene	0.0439	0.220	b	9.66E-03	Regresson	d2	2.69E-02	0.000	d	0.00E+00	0	1.03E-04	65.6	g	147	328	g	1.56E-06	6.99E-07	3.13E-07
Anthracene	9.47	0.320	b	3.03E+00	Regresson	d3	2.14E+00	0.000	d	0.00E+00	0	1.51E-02	65.6	g	147	328	g	2.31E-04	1.03E-04	4.62E-05
Benzo(a)anthracene	59.7	0.270	b	1.61E+01	Regresson	d4	7.58E-01	0.000	d	0.00E+00	0	6.59E-02	0.62	g	1.37	3.07	g	1.07E-01	4.80E-02	2.15E-02
Benzo(a)pyrene	52.7	0.340	b	1.79E+01	Regresson	d5	6.07E+00	0.000	d	0.00E+00	0	7.28E-02	0.62	g	1.37	3.07	g	1.18E-01	5.30E-02	2.37E-02
Benzo(b)fluoranthene	65.2	0.210	b	1.37E+01	0.310	d	2.02E+01	0.000	d	0.00E+00	0	1.10E-01	0.62	g	1.37	3.07	g	1.79E-01	8.00E-02	3.58E-02
Benzo(g,h,i)perylene	23.9	0.150	b	3.58E+00	Regresson	d6	1.68E+01	0.000	d	0.00E+00	0	5.90E-02	0.62	g	1.37	3.07	g	9.59E-02	4.29E-02	1.92E-02
Benzo(k)fluoranthene	25.7	0.210	b	5.41E+00	Regresson	d7	1.88E+00	0.000	d	0.00E+00	0	3.04E-02	0.62	g	1.37	3.07	g	4.95E-02	2.22E-02	9.91E-03
Chrysene	64.2	0.440	b	2.82E+01	Regresson	d8	7.91E-01	0.000	d	0.00E+00	0	8.01E-02	0.62	g	1.37	3.07	g	1.30E-01	5.83E-02	2.61E-02
Dibenz(a,h)anthracene	7.02	0.490	b	3.44E+00	0.130	d	9.13E-01	0.000	d	0.00E+00	0	1.08E-02	0.62	g	1.37	3.07	g	1.76E-02	7.87E-03	3.52E-03
Fluoranthene	99.1	0.370	b	3.67E+01	0.500	d	4.95E+01	0.000	d	0.00E+00	0	2.20E-01	65.6	g	147	328	g	3.36E-03	1.50E-03	6.72E-04
Fluorene	1.63	0.200	b	3.27E-01	Regresson	d9	2.52E-03	0.000	d	0.00E+00	0	1.67E-03	65.6	g	147	328	g	2.55E-05	1.14E-05	5.09E-06
Indeno(1,2,3-cd)pyrene	22.6	0.410	b	9.25E+00	0.110	d	2.48E+00	0.000	d	0.00E+00	0	3.23E-02	0.62	g	1.37	3.07	g	5.24E-02	2.35E-02	1.05E-02
Phenanthrene	41.8	0.280	b	1.17E+01	Regresson	d10	8.58E+00	0.000	d	0.00E+00	0	6.36E-02	65.6	g	147	328	g	9.70E-04	4.34E-04	1.94E-04
Pyrene	84.8	0.390	b	3.31E+01	0.720	d	6.11E+01	0.000	d	0.00E+00	0	2.30E-01	0.62	g	1.37	3.07	g	3.73E-01	1.67E-01	7.48E-02

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.1231 = Food ingestion rate (kg/day dry weight) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.028 = Proportion of diet composed of food item (soil invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.070 = Proportion of diet composed of food item (terrestrial plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (small mammals, dry weight basis)
PDFi = 0.874 = Proportion of diet composed of food item (small mammals) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.028 = Proportion of diet composed of soil (Beyer et al. 1994)
WIR = 0.3494 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 4.06 = Body weight (kg) (Silva and Downing 1995)

a Sample et al. 1998a
$C_w = e^{(-0.218 + 0.807(\ln Cs))}$
b Beyer and Stafford 1993 (median)
c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln Cs))}$
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Sample et al. 1998b (omnivore)
$C_m = e^{(0.0761 + 0.4422(\ln Cs))}$
f USEPA 2005c
g USEPA 2007d

Table 8-14a
Summary of Red-tailed Hawk Exposure Doses - Initial - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Soil-Mammal BAF		Small Mammal Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	13,600	1.522	a	2.07E+04	0.468	c	6.36E+03	0.286	e	3.89E+03	0	1.61E+02	3.85	f	8.61	19.3	g	4.17E+01	1.87E+01	8.34E+00
PAHs																				
Acenaphthene	13.5	0.300	b	4.05E+00	Regresson	d1	4.14E-04	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Acenaphthylene	0.0036	0.220	b	7.81E-04	Regresson	d2	3.68E-03	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Anthracene	54.0	0.320	b	1.73E+01	Regresson	d3	8.30E+00	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Benzo(a)anthracene	302	0.270	b	8.15E+01	Regresson	d4	1.99E+00	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	279	0.340	b	9.49E+01	Regresson	d5	3.08E+01	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Benzo(b)fluoranthene	329	0.210	b	6.91E+01	0.310	d	1.02E+02	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Benzo(g,h,i)perylene	113	0.150	b	1.70E+01	Regresson	d6	1.06E+02	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Benzo(k)fluoranthene	129	0.210	b	2.71E+01	Regresson	d7	7.53E+00	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Chrysene	315	0.440	b	1.39E+02	Regresson	d8	2.04E+00	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Dibenz(a,h)anthracene	31.8	0.490	b	1.56E+01	0.130	d	4.13E+00	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Fluoranthene	545	0.370	b	2.02E+02	0.500	d	2.73E+02	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Fluorene	10.1	0.200	b	2.02E+00	Regresson	d9	5.31E-04	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	102	0.410	b	4.18E+01	0.110	d	1.12E+01	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Phenanthrene	253	0.280	b	7.08E+01	Regresson	d10	2.62E+01	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Pyrene	466	0.390	b	1.82E+02	0.720	d	3.36E+02	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0395 = Food ingestion rate (kg/day dry weight) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (terrestrial plants) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (small mammals, dry weight basis)
PDFi = 1.000 = Proportion of diet composed of food item (small mammals) (Sample and Suter 1994)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.000 = Proportion of diet composed of soil (Sample and Suter 1994)
WIR = 0.0680 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.957 = Body weight (kg) (USEPA 1993a)

a Sample et al. 1998a (90th percentile)
b Beyer and Stafford 1993 (median)
c Bechtel Jacobs 1998a (90th percentile)
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Sample et al. 1998b (90th percentile - omnivore)
f Sample et al. 1996
g NOAEL multiplied by 5
h Rigdon and Neal 1963

Table 8-14b

Summary of Red-tailed Hawk Exposure Doses - Refined - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Surface Soil Concentration (mg/kg)	Soil-Worm BAF		Terrestrial Invertebrate Concentration (mg/kg dw)	Soil-Plant BAF		Terrestrial Plant Concentration (mg/kg dw)	Soil-Mammal BAF		Small Mammal Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	1,274	Regression	a	2.58E+02	Regresson	c	1.46E+01	Regresson	e	2.55E+01	0	8.15E-01	3.85	f	8.61	19.3	g	2.12E-01	9.47E-02	4.24E-02
PAHs																				
Acenaphthene	2.45	0.300	b	7.35E-01	Regresson	d1	1.78E-03	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Acenaphthylene	0.0439	0.220	b	9.66E-03	Regresson	d2	2.69E-02	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Anthracene	9.47	0.320	b	3.03E+00	Regresson	d3	2.14E+00	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Benzo(a)anthracene	59.7	0.270	b	1.61E+01	Regresson	d4	7.58E-01	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	52.7	0.340	b	1.79E+01	Regresson	d5	6.07E+00	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Benzo(b)fluoranthene	65.2	0.210	b	1.37E+01	0.310	d	2.02E+01	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Benzo(g,h,i)perylene	23.9	0.150	b	3.58E+00	Regresson	d6	1.68E+01	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Benzo(k)fluoranthene	25.7	0.210	b	5.41E+00	Regresson	d7	1.88E+00	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Chrysene	64.2	0.440	b	2.82E+01	Regresson	d8	7.91E-01	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Dibenz(a,h)anthracene	7.02	0.490	b	3.44E+00	0.130	d	9.13E-01	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Fluoranthene	99.1	0.370	b	3.67E+01	0.500	d	4.95E+01	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Fluorene	1.63	0.200	b	3.27E-01	Regresson	d9	2.52E-03	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	22.6	0.410	b	9.25E+00	0.110	d	2.48E+00	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Phenanthrene	41.8	0.280	b	1.17E+01	Regresson	d10	8.58E+00	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00
Pyrene	84.8	0.390	b	3.31E+01	0.720	d	6.11E+01	0.000	d	0.00E+00	0	0.00E+00	7.10	h	15.9	35.5	g	0.00E+00	0.00E+00	0.00E+00

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0360 = Food ingestion rate (kg/day dry weight) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (soil invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (soil invertebrates) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (terrestrial plants, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (terrestrial plants) (Sample and Suter 1994)
FCxi = Chemical-specific = Concentration of chemical in food item (small mammals, dry weight basis)
PDFi = 1.000 = Proportion of diet composed of food item (small mammals) (Sample and Suter 1994)
SCx = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
PDS = 0.000 = Proportion of diet composed of soil (Sample and Suter 1994)
WIR = 0.0639 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 1.126 = Body weight (kg) (Sample and Suter 1994)

a Sample et al. 1998a
$C_w = e^{(-0.218 + 0.807(\ln Cs))}$
b Beyer and Stafford 1993 (median)
c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln Cs))}$
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Sample et al. 1998b (omnivore)
$C_m = e^{(0.0761 + 0.4422(\ln Cs))}$
f Sample et al. 1996
g NOAEL multiplied by 5
h Rigdon and Neal 1963

Table 8-15
Ecological Screening Statistics - Skeet and Trap Range Sediment
Fleet Combat Training Center - Dam Neck

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL (Norm)	Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient[2]	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
PAHs (UG/KG)															
2-Methylnaphthalene	4.12 - 4.22	0 / 2	--	--	--	2.09	0.035	2.24	20.2	-- / --	0.209	NO	--	--	NO
Acenaphthene	4.12 - 4.22	0 / 2	--	--	--	2.09	0.035	2.24	290	-- / --	0.015	NO	--	--	NO
Acenaphthylene	4.12 - 4.22	0 / 2	--	--	--	2.09	0.035	2.24	160	-- / --	0.026	NO	--	--	NO
Anthracene	4.22 - 4.22	1 / 2	2.77	2.77	DNSTR-SD01-0511	2.44	0.47	4.52	57.2	0 / 2	0.048	NO	--	--	NO
Benzo(a)anthracene	4.22 - 4.22	1 / 2	8.22	8.22	DNSTR-SD01-0511	5.17	4.32	24.5	108	0 / 2	0.076	NO	--	--	NO
Benzo(a)pyrene	4.22 - 4.22	1 / 2	9.26	9.26	DNSTR-SD01-0511	5.69	5.06	28.3	150	0 / 2	0.062	NO	--	--	NO
Benzo(b)fluoranthene	4.22 - 4.22	1 / 2	10.5	10.5	DNSTR-SD01-0511	6.31	5.93	32.8	240	0 / 2	0.044	NO	--	--	NO
Benzo(g,h,i)perylene	4.22 - 4.22	1 / 2	6.38	6.38	DNSTR-SD01-0511	4.25	3.02	17.7	170	0 / 2	0.038	NO	--	--	NO
Benzo(k)fluoranthene	4.12 - 4.22	0 / 2	--	--	--	2.09	0.035	2.24	240	-- / --	0.018	NO	--	--	NO
Chrysene	4.22 - 4.22	1 / 2	9.31	9.31	DNSTR-SD01-0511	5.71	5.09	28.4	166	0 / 2	0.056	NO	--	--	NO
Dibenz(a,h)anthracene	4.12 - 4.22	0 / 2	--	--	--	2.09	0.035	2.24	33.0	-- / --	0.128	NO	--	--	NO
Fluoranthene	-- - --	2 / 2	2.28	25.6	DNSTR-SD01-0511	13.9	16.5	87.6	423	0 / 2	0.061	NO	--	--	NO
Fluorene	4.12 - 4.22	0 / 2	--	--	--	2.09	0.035	2.24	77.4	-- / --	0.055	NO	--	--	NO
Indeno(1,2,3-cd)pyrene	4.22 - 4.22	1 / 2	4.78	4.78	DNSTR-SD01-0511	3.45	1.89	11.9	200	0 / 2	0.024	NO	--	--	NO
Naphthalene	4.12 - 4.22	0 / 2	--	--	--	2.09	0.035	2.24	176	-- / --	0.024	NO	--	--	NO
Phenanthrene	4.22 - 4.22	1 / 2	13.7	13.7	DNSTR-SD01-0511	7.91	8.20	44.5	204	0 / 2	0.067	NO	--	--	NO
Pyrene	4.22 - 4.22	1 / 2	18.9	18.9	DNSTR-SD01-0511	10.5	11.9	63.5	195	0 / 2	0.097	NO	--	--	NO
PAH (HMW)	19.0 - 19.0	1 / 2	71.3	71.3	DNSTR-SD01-0511	40.4	43.7	235	2,900	0 / 2	0.025	NO	--	--	NO
PAH (LMW)	-- - --	2 / 2	17.1	51.8	DNSTR-SD01-0511	34.4	24.6	144	786	0 / 2	0.066	NO	--	--	NO
PAH (total)	-- - --	2 / 2	36.0	123	DNSTR-SD01-0511	79.6	61.6	354	3,553	0 / 2	0.035	NO	--	--	NO
Inorganics (MG/KG)															
Lead	-- - --	20 / 20	6.49	1,130	DNSTR-SD09-0511	80.8	249	177	35.8	4 / 20	31.6	YES	4.94	2.26	YES
Other Parameters															
pH	-- - --	15 / 15	6.16	7.04	DNSTR-SD01-0511	6.72	0.28	6.85	--	-- / --	--	--	--	--	--
Total organic carbon (MG/KG)	-- - --	15 / 15	1,900	52,800	DNSTR-SD13-0511	12,262	15,540	19,329	--	-- / --	--	--	--	--	--

1 - Count of detected samples exceeding or equaling Screening Value
2 - Shaded cells indicate hazard quotient based on reporting limits

Table 8-16
Exceedances - Skeet and Trap Range Sediment
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Sediment Screening Value	DNSTR-SD01		DNSTR-SD02	DNSTR-SD03	DNSTR-SD04	DNSTR-SD05
		DNSTR-SD01-0511	DNSTR-SD01P-0511	DNSTR-SD02-0511	DNSTR-SD03-0511	DNSTR-SD04-0511	DNSTR-SD05-0511
		05/09/11	05/09/11	05/09/11	05/10/11	05/10/11	05/10/11
PAHs (UG/KG)							
Anthracene	57.2	2.77 J	4.12 U	4.22 UJ	NA	NA	NA
Benzo(a)anthracene	108	8.22	4.12 U	4.22 UJ	NA	NA	NA
Benzo(a)pyrene	150	9.26	4.12 U	4.22 UJ	NA	NA	NA
Benzo(b)fluoranthene	240	10.5	4.12 U	4.22 UJ	NA	NA	NA
Benzo(g,h,i)perylene	170	6.38 J	4.12 U	4.22 UJ	NA	NA	NA
Chrysene	166	9.31	4.12 U	4.22 UJ	NA	NA	NA
Fluoranthene	423	25.6 J	4.12 UJ	2.28 J	NA	NA	NA
Indeno(1,2,3-cd)pyrene	200	4.78 J	4.12 U	4.22 UJ	NA	NA	NA
Phenanthrene	204	13.7	4.12 U	4.22 UJ	NA	NA	NA
Pyrene	195	18.9 J	4.12 UJ	4.22 UJ	NA	NA	NA
PAH (HMW)	2,900	71.3	18.5 U	19.0 U	NA	NA	NA
PAH (LMW)	786	51.8	16.5 U	17.1	NA	NA	NA
PAH (total)	3,553	123	35.0 U	36.0	NA	NA	NA
Inorganics (MG/KG)							
Lead	35.8	11.7	10.2	33.8 J	12.3	11.7	11.0
Pellet Count							
Number	--	0 Visual	NA	0 Visual	0 Visual	0 Visual	0
Other Parameters							
pH	--	6.78	7.04	6.67	7.03	6.80	NA
Total organic carbon (MG/KG)	--	3,550	3,100	2,130	4,660	5,340	NA

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections
NA - Not analyzed

Table 8-16
Exceedances - Skeet and Trap Range Sediment
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Sediment Screening Value	DNSTR-SD06	DNSTR-SD07	DNSTR-SD08	DNSTR-SD09	DNSTR-SD10	DNSTR-SD11
		DNSTR-SD06-0511	DNSTR-SD07-0511	DNSTR-SD08-0511	DNSTR-SD09-0511	DNSTR-SD10-0511	DNSTR-SD11-0511
		05/10/11	05/10/11	05/10/11	05/10/11	05/10/11	05/10/11
PAHs (UG/KG)							
Anthracene	57.2	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	108	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	150	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	240	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	170	NA	NA	NA	NA	NA	NA
Chrysene	166	NA	NA	NA	NA	NA	NA
Fluoranthene	423	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	200	NA	NA	NA	NA	NA	NA
Phenanthrene	204	NA	NA	NA	NA	NA	NA
Pyrene	195	NA	NA	NA	NA	NA	NA
PAH (HMW)	2,900	NA	NA	NA	NA	NA	NA
PAH (LMW)	786	NA	NA	NA	NA	NA	NA
PAH (total)	3,553	NA	NA	NA	NA	NA	NA
Inorganics (MG/KG)							
Lead	35.8	8.07	12.5	6.49	1,130	130	14.2
Pellet Count							
Number	--	2	0 Visual	18	0 Visual	0	0 Visual
Other Parameters							
pH	--	NA	6.18	6.88	6.76	6.16	NA
Total organic carbon (MG/KG)	--	NA	7,640	8,930	11,300	1,900	NA

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections
NA - Not analyzed

Table 8-16
Exceedances - Skeet and Trap Range Sediment
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Sediment Screening Value	DNSTR-SD12 DNSTR-SD12-0511 05/10/11	DNSTR-SD13 DNSTR-SD13-0511 05/10/11	DNSTR-SD14 DNSTR-SD14-0511 05/10/11	DNSTR-SD15 DNSTR-SD15-0511 05/10/11	DNSTR-SD16 DNSTR-SD16-0511 05/10/11
PAHs (UG/KG)						
Anthracene	57.2	NA	NA	NA	NA	NA
Benzo(a)anthracene	108	NA	NA	NA	NA	NA
Benzo(a)pyrene	150	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	240	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	170	NA	NA	NA	NA	NA
Chrysene	166	NA	NA	NA	NA	NA
Fluoranthene	423	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	200	NA	NA	NA	NA	NA
Phenanthrene	204	NA	NA	NA	NA	NA
Pyrene	195	NA	NA	NA	NA	NA
PAH (HMW)	2,900	NA	NA	NA	NA	NA
PAH (LMW)	786	NA	NA	NA	NA	NA
PAH (total)	3,553	NA	NA	NA	NA	NA
Inorganics (MG/KG)						
Lead	35.8	14.1	60.7	18.8	17.9	27.1
Pellet Count						
Number	--	0	0	1	0	0 Visual
Other Parameters						
pH	--	NA	6.35	6.86	6.75	6.75
Total organic carbon (MG/KG)	--	NA	52,800	25,500	3,230	41,800

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections
NA - Not analyzed

Table 8-16
Exceedances - Skeet and Trap Range Sediment
Fleet Combat Training Center - Dam Neck Annex

Chemical	Ecological Sediment Screening Value	DNSTR-SD17		DNSTR-SD18	DNSTR-SD19	DNSTR-SD20
		DNSTR-SD17-0511	DNSTR-SD17P-0511	DNSTR-SD18-0511	DNSTR-SD19-0511	DNSTR-SD20-0511
		05/10/11	05/10/11	05/10/11	05/10/11	05/10/11
PAHs (UG/KG)						
Anthracene	57.2	NA	NA	NA	NA	NA
Benzo(a)anthracene	108	NA	NA	NA	NA	NA
Benzo(a)pyrene	150	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	240	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	170	NA	NA	NA	NA	NA
Chrysene	166	NA	NA	NA	NA	NA
Fluoranthene	423	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	200	NA	NA	NA	NA	NA
Phenanthrene	204	NA	NA	NA	NA	NA
Pyrene	195	NA	NA	NA	NA	NA
PAH (HMW)	2,900	NA	NA	NA	NA	NA
PAH (LMW)	786	NA	NA	NA	NA	NA
PAH (total)	3,553	NA	NA	NA	NA	NA
Inorganics (MG/KG)						
Lead	35.8	48.8	41.8	6.54	28.5	11.9
Pellet Count						
Number	--	0 Visual	NA	0	8	2
Other Parameters						
pH	--	NA	NA	6.72	6.94	6.91
Total organic carbon (MG/KG)	--	NA	NA	9,180	3,930	2,040

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections
NA - Not analyzed

Table 8-17a

Summary of Mink Exposure Doses - Initial - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	1,130	0.326	a	3.68E+02	0.468	c	5.29E+02	0.070	e	7.91E+01	0	4.66E+00	4.70	f	6.47	8.90	f	9.92E-01	7.21E-01	5.24E-01
PAHs																				
Acenaphthene	0.00422	1.000	b	4.22E-03	Regresson	d1	4.13E-01	1.000	b	4.22E-03	0	3.95E-04	65.6	g	147	328	g	6.02E-06	2.69E-06	1.20E-06
Acenaphthylene	0.00422	1.000	b	4.22E-03	Regresson	d2	4.21E-03	1.000	b	4.22E-03	0	2.01E-04	65.6	g	147	328	g	3.06E-06	1.37E-06	6.12E-07
Anthracene	0.00277	1.000	b	2.77E-03	Regresson	d3	3.80E-03	1.000	b	2.77E-03	0	1.32E-04	65.6	g	147	328	g	2.01E-06	9.01E-07	4.03E-07
Benzo(a)anthracene	0.00822	1.000	b	8.22E-03	Regresson	d4	3.84E-03	1.000	b	8.22E-03	0	3.89E-04	0.62	g	1.37	3.07	g	6.32E-04	2.83E-04	1.27E-04
Benzo(a)pyrene	0.00926	1.000	b	9.26E-03	Regresson	d5	1.32E-03	1.000	b	9.26E-03	0	4.36E-04	0.62	g	1.37	3.07	g	7.10E-04	3.18E-04	1.42E-04
Benzo(b)fluoranthene	0.01050	1.000	b	1.05E-02	0.310	d	3.26E-03	1.000	b	1.05E-02	0	4.96E-04	0.62	g	1.37	3.07	g	8.06E-04	3.61E-04	1.61E-04
Benzo(g,h,i)perylene	0.00638	1.000	b	6.38E-03	Regresson	d6	9.97E-04	1.000	b	6.38E-03	0	3.01E-04	0.62	g	1.37	3.07	g	4.89E-04	2.19E-04	9.80E-05
Benzo(k)fluoranthene	0.00422	1.000	b	4.22E-03	Regresson	d7	1.05E-03	1.000	b	4.22E-03	0	1.99E-04	0.62	g	1.37	3.07	g	3.24E-04	1.45E-04	6.49E-05
Chrysene	0.00931	1.000	b	9.31E-03	Regresson	d8	4.14E-03	1.000	b	9.31E-03	0	4.40E-04	0.62	g	1.37	3.07	g	7.16E-04	3.20E-04	1.43E-04
Dibenz(a,h)anthracene	0.00422	1.000	b	4.22E-03	0.130	d	5.49E-04	1.000	b	4.22E-03	0	1.99E-04	0.62	g	1.37	3.07	g	3.23E-04	1.45E-04	6.48E-05
Fluoranthene	0.02560	1.000	b	2.56E-02	0.500	d	1.28E-02	1.000	b	2.56E-02	0	1.21E-03	65.6	g	147	328	g	1.85E-05	8.26E-06	3.69E-06
Fluorene	0.00422	1.000	b	4.22E-03	Regresson	d9	4.13E-01	1.000	b	4.22E-03	0	3.95E-04	65.6	g	147	328	g	6.02E-06	2.69E-06	1.20E-06
Indeno(1,2,3-cd)pyrene	0.00478	1.000	b	4.78E-03	0.110	d	5.26E-04	1.000	b	4.78E-03	0	2.25E-04	0.62	g	1.37	3.07	g	3.66E-04	1.64E-04	7.34E-05
Phenanthrene	0.01370	1.000	b	1.37E-02	Regresson	d10	5.91E-02	1.000	b	1.37E-02	0	6.73E-04	65.6	g	147	328	g	1.03E-05	4.59E-06	2.05E-06
Pyrene	0.01890	1.000	b	1.89E-02	0.720	d	1.36E-02	1.000	b	1.89E-02	0	8.96E-04	0.62	g	1.37	3.07	g	1.46E-03	6.52E-04	2.92E-04

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0345 = Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.050 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.010 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 0.940 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.000 = Proportion of diet composed of sediment (Sample and Suter 1994)
WIR = 0.0286 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.726 = Body weight (kg) (Silva and Downing 1995)

a Bechtel Jacobs 1998b (90th percentile)
b Assumed value
c Bechtel Jacobs 1998a (90th percentile)
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f USEPA 2005c
g USEPA 2007d

Table 8-17b
Summary of Mink Exposure Doses - Refined - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	80.8	Regression	a	5.38E+00	Regresson	c	3.11E+00	0.070	e	5.66E+00	0	1.90E-01	4.70	f	6.47	8.90	f	4.04E-02	2.94E-02	2.14E-02
PAHs																				
Acenaphthene	0.00209	1.000	b	2.09E-03	Regresson	d1	7.55E-01	1.000	b	2.09E-03	0	3.25E-04	65.6	g	147	328	g	4.96E-06	2.22E-06	9.92E-07
Acenaphthylene	0.00209	1.000	b	2.09E-03	Regresson	d2	2.41E-03	1.000	b	2.09E-03	0	7.07E-05	65.6	g	147	328	g	1.08E-06	4.82E-07	2.15E-07
Anthracene	0.00244	1.000	b	2.44E-03	Regresson	d3	3.44E-03	1.000	b	2.44E-03	0	8.29E-05	65.6	g	147	328	g	1.26E-06	5.65E-07	2.53E-07
Benzo(a)anthracene	0.00517	1.000	b	5.17E-03	Regresson	d4	2.92E-03	1.000	b	5.17E-03	0	1.74E-04	0.62	g	1.37	3.07	g	2.83E-04	1.27E-04	5.67E-05
Benzo(a)pyrene	0.00569	1.000	b	5.69E-03	Regresson	d5	8.23E-04	1.000	b	5.69E-03	0	1.91E-04	0.62	g	1.37	3.07	g	3.10E-04	1.39E-04	6.21E-05
Benzo(b)fluoranthene	0.00631	1.000	b	6.31E-03	0.310	d	1.95E-03	1.000	b	6.31E-03	0	2.12E-04	0.62	g	1.37	3.07	g	3.45E-04	1.54E-04	6.90E-05
Benzo(g,h,i)perylene	0.00425	1.000	b	4.25E-03	Regresson	d6	6.16E-04	1.000	b	4.25E-03	0	1.42E-04	0.62	g	1.37	3.07	g	2.32E-04	1.04E-04	4.64E-05
Benzo(k)fluoranthene	0.00209	1.000	b	2.09E-03	Regresson	d7	5.74E-04	1.000	b	2.09E-03	0	7.00E-05	0.62	g	1.37	3.07	g	1.14E-04	5.10E-05	2.28E-05
Chrysene	0.00571	1.000	b	5.71E-03	Regresson	d8	3.09E-03	1.000	b	5.71E-03	0	1.92E-04	0.62	g	1.37	3.07	g	3.13E-04	1.40E-04	6.27E-05
Dibenz(a,h)anthracene	0.00209	1.000	b	2.09E-03	0.130	d	2.71E-04	1.000	b	2.09E-03	0	6.99E-05	0.62	g	1.37	3.07	g	1.14E-04	5.09E-05	2.28E-05
Fluoranthene	0.01394	1.000	b	1.39E-02	0.500	d	6.97E-03	1.000	b	1.39E-02	0	4.69E-04	65.6	g	147	328	g	7.15E-06	3.20E-06	1.43E-06
Fluorene	0.00209	1.000	b	2.09E-03	Regresson	d9	7.55E-01	1.000	b	2.09E-03	0	3.25E-04	65.6	g	147	328	g	4.96E-06	2.22E-06	9.92E-07
Indeno(1,2,3-cd)pyrene	0.00345	1.000	b	3.45E-03	0.110	d	3.79E-04	1.000	b	3.45E-03	0	1.16E-04	0.62	g	1.37	3.07	g	1.88E-04	8.41E-05	3.76E-05
Phenanthrene	0.00791	1.000	b	7.91E-03	Regresson	d10	4.20E-02	1.000	b	7.91E-03	0	2.79E-04	65.6	g	147	328	g	4.25E-06	1.90E-06	8.51E-07
Pyrene	0.01051	1.000	b	1.05E-02	0.720	d	7.56E-03	1.000	b	1.05E-02	0	3.54E-04	0.62	g	1.37	3.07	g	5.76E-04	2.58E-04	1.15E-04

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0263 = Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.050 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.010 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 0.940 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.000 = Proportion of diet composed of sediment (Sample and Suter 1994)
WIR = 0.0218 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.777 = Body weight (kg) (Silva and Downing 1995)

a Bechtel Jacobs 1998b
$C_i = e^{(-0.515 + 0.653(\log Cs))}$
b Assumed value
c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln Cs))}$

d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f USEPA 2005c
g USEPA 2007d

Table 8-18a
Summary of Raccoon Exposure Doses - Initial - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	1,130	0.326	a	3.68E+02	0.468	c	5.29E+02	0.070	e	7.91E+01	0	1.49E+01	4.70	f	6.47	8.90	f	3.18E+00	2.31E+00	1.68E+00
PAHs																				
Acenaphthene	0.00422	1.000	b	4.22E-03	Regresson	d1	4.13E-01	1.000	b	4.22E-03	0	5.18E-03	65.6	g	147	328	g	7.90E-05	3.53E-05	1.58E-05
Acenaphthylene	0.00422	1.000	b	4.22E-03	Regresson	d2	4.21E-03	1.000	b	4.22E-03	0	1.30E-04	65.6	g	147	328	g	1.99E-06	8.88E-07	3.97E-07
Anthracene	0.00277	1.000	b	2.77E-03	Regresson	d3	3.80E-03	1.000	b	2.77E-03	0	9.83E-05	65.6	g	147	328	g	1.50E-06	6.70E-07	3.00E-07
Benzo(a)anthracene	0.00822	1.000	b	8.22E-03	Regresson	d4	3.84E-03	1.000	b	8.22E-03	0	2.00E-04	0.62	g	1.37	3.07	g	3.25E-04	1.45E-04	6.51E-05
Benzo(a)pyrene	0.00926	1.000	b	9.26E-03	Regresson	d5	1.32E-03	1.000	b	9.26E-03	0	1.88E-04	0.62	g	1.37	3.07	g	3.06E-04	1.37E-04	6.12E-05
Benzo(b)fluoranthene	0.01050	1.000	b	1.05E-02	0.310	d	3.26E-03	1.000	b	1.05E-02	0	2.35E-04	0.62	g	1.37	3.07	g	3.82E-04	1.71E-04	7.65E-05
Benzo(g,h,i)perylene	0.00638	1.000	b	6.38E-03	Regresson	d6	9.97E-04	1.000	b	6.38E-03	0	1.31E-04	0.62	g	1.37	3.07	g	2.12E-04	9.50E-05	4.25E-05
Benzo(k)fluoranthene	0.00422	1.000	b	4.22E-03	Regresson	d7	1.05E-03	1.000	b	4.22E-03	0	9.12E-05	0.62	g	1.37	3.07	g	1.48E-04	6.64E-05	2.97E-05
Chrysene	0.00931	1.000	b	9.31E-03	Regresson	d8	4.14E-03	1.000	b	9.31E-03	0	2.24E-04	0.62	g	1.37	3.07	g	3.64E-04	1.63E-04	7.29E-05
Dibenz(a,h)anthracene	0.00422	1.000	b	4.22E-03	0.130	d	5.49E-04	1.000	b	4.22E-03	0	8.50E-05	0.62	g	1.37	3.07	g	1.38E-04	6.19E-05	2.77E-05
Fluoranthene	0.02560	1.000	b	2.56E-02	0.500	d	1.28E-02	1.000	b	2.56E-02	0	6.33E-04	65.6	g	147	328	g	9.64E-06	4.31E-06	1.93E-06
Fluorene	0.00422	1.000	b	4.22E-03	Regresson	d9	4.13E-01	1.000	b	4.22E-03	0	5.18E-03	65.6	g	147	328	g	7.90E-05	3.53E-05	1.58E-05
Indeno(1,2,3-cd)pyrene	0.00478	1.000	b	4.78E-03	0.110	d	5.26E-04	1.000	b	4.78E-03	0	9.51E-05	0.62	g	1.37	3.07	g	1.55E-04	6.92E-05	3.10E-05
Phenanthrene	0.01370	1.000	b	1.37E-02	Regresson	d10	5.91E-02	1.000	b	1.37E-02	0	9.85E-04	65.6	g	147	328	g	1.50E-05	6.71E-06	3.00E-06
Pyrene	0.01890	1.000	b	1.89E-02	0.720	d	1.36E-02	1.000	b	1.89E-02	0	5.18E-04	0.62	g	1.37	3.07	g	8.43E-04	3.77E-04	1.69E-04

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.1307 = Food ingestion rate (kg/day dry weight) (Conover 1989)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.436 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.400 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 0.070 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.094 = Proportion of diet composed of sediment (Beyer et al. 1994)
WIR = 0.6092 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 4.23 = Body weight (kg) (Silva and Downing 1995)

a Bechtel Jacobs 1998b (90th percentile)
b Assumed value
c Bechtel Jacobs 1998a (90th percentile)
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f USEPA 2005c
g USEPA 2007d

Table 8-18b

Summary of Raccoon Exposure Doses - Refined - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	80.8	Regression	a	5.38E+00	Regresson	c	3.11E+00	0.070	e	5.66E+00	0	2.01E-01	4.70	f	6.47	8.90	f	4.28E-02	3.11E-02	2.26E-02
PAHs																				
Acenaphthene	0.00209	1.000	b	2.09E-03	Regresson	d1	7.55E-01	1.000	b	2.09E-03	0	5.27E-03	65.6	g	147	328	g	8.03E-05	3.59E-05	1.61E-05
Acenaphthylene	0.00209	1.000	b	2.09E-03	Regresson	d2	2.41E-03	1.000	b	2.09E-03	0	3.85E-05	65.6	g	147	328	g	5.86E-07	2.62E-07	1.17E-07
Anthracene	0.00244	1.000	b	2.44E-03	Regresson	d3	3.44E-03	1.000	b	2.44E-03	0	4.93E-05	65.6	g	147	328	g	7.52E-07	3.36E-07	1.50E-07
Benzo(a)anthracene	0.00517	1.000	b	5.17E-03	Regresson	d4	2.92E-03	1.000	b	5.17E-03	0	7.40E-05	0.62	g	1.37	3.07	g	1.20E-04	5.39E-05	2.41E-05
Benzo(a)pyrene	0.00569	1.000	b	5.69E-03	Regresson	d5	8.23E-04	1.000	b	5.69E-03	0	6.49E-05	0.62	g	1.37	3.07	g	1.06E-04	4.72E-05	2.11E-05
Benzo(b)fluoranthene	0.00631	1.000	b	6.31E-03	0.310	d	1.95E-03	1.000	b	6.31E-03	0	7.92E-05	0.62	g	1.37	3.07	g	1.29E-04	5.77E-05	2.58E-05
Benzo(g,h,i)perylene	0.00425	1.000	b	4.25E-03	Regresson	d6	6.16E-04	1.000	b	4.25E-03	0	4.85E-05	0.62	g	1.37	3.07	g	7.88E-05	3.53E-05	1.58E-05
Benzo(k)fluoranthene	0.00209	1.000	b	2.09E-03	Regresson	d7	5.74E-04	1.000	b	2.09E-03	0	2.57E-05	0.62	g	1.37	3.07	g	4.18E-05	1.87E-05	8.37E-06
Chrysene	0.00571	1.000	b	5.71E-03	Regresson	d8	3.09E-03	1.000	b	5.71E-03	0	8.09E-05	0.62	g	1.37	3.07	g	1.32E-04	5.89E-05	2.64E-05
Dibenz(a,h)anthracene	0.00209	1.000	b	2.09E-03	0.130	d	2.71E-04	1.000	b	2.09E-03	0	2.36E-05	0.62	g	1.37	3.07	g	3.84E-05	1.72E-05	7.68E-06
Fluoranthene	0.01394	1.000	b	1.39E-02	0.500	d	6.97E-03	1.000	b	1.39E-02	0	1.94E-04	65.6	g	147	328	g	2.95E-06	1.32E-06	5.90E-07
Fluorene	0.00209	1.000	b	2.09E-03	Regresson	d9	7.55E-01	1.000	b	2.09E-03	0	5.27E-03	65.6	g	147	328	g	8.03E-05	3.59E-05	1.61E-05
Indeno(1,2,3-cd)pyrene	0.00345	1.000	b	3.45E-03	0.110	d	3.79E-04	1.000	b	3.45E-03	0	3.85E-05	0.62	g	1.37	3.07	g	6.26E-05	2.80E-05	1.25E-05
Phenanthrene	0.00791	1.000	b	7.91E-03	Regresson	d10	4.20E-02	1.000	b	7.91E-03	0	3.74E-04	65.6	g	147	328	g	5.70E-06	2.55E-06	1.14E-06
Pyrene	0.01051	1.000	b	1.05E-02	0.720	d	7.56E-03	1.000	b	1.05E-02	0	1.62E-04	0.62	g	1.37	3.07	g	2.63E-04	1.18E-04	5.27E-05

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.1031 = Food ingestion rate (kg/day dry weight) (Conover 1989)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.436 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.400 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 0.070 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.094 = Proportion of diet composed of sediment (Beyer et al. 1994)
WIR = 0.4921 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 5.94 = Body weight (kg) (Silva and Downing 1995)

a Bechtel Jacobs 1998b
$C_i = e^{(-0.515 + 0.653(\log C_s))}$
b Assumed value
c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln C_s))}$
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln C_s))}$
2 $C_n = e^{(-1.144 + 0.791(\ln C_s))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln C_s))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln C_s))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln C_s))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln C_s))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln C_s))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln C_s))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln C_s))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln C_s))}$
e Krantzberg and Boyd 1992
f USEPA 2005c
g USEPA 2007d

Table 8-19a
Summary of Muskrat Exposure Doses - Initial - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	1,130	0.326	a	3.68E+02	0.468	c	5.29E+02	0.070	e	7.91E+01	0	5.97E+01	4.70	f	6.47	8.90	f	1.27E+01	9.23E+00	6.71E+00
PAHs																				
Acenaphthene	0.00422	1.000	b	4.22E-03	Regresson	d1	4.13E-01	1.000	b	4.22E-03	0	3.82E-02	65.6	g	147	328	g	5.83E-04	2.61E-04	1.17E-04
Acenaphthylene	0.00422	1.000	b	4.22E-03	Regresson	d2	4.21E-03	1.000	b	4.22E-03	0	4.30E-04	65.6	g	147	328	g	6.55E-06	2.93E-06	1.31E-06
Anthracene	0.00277	1.000	b	2.77E-03	Regresson	d3	3.80E-03	1.000	b	2.77E-03	0	3.78E-04	65.6	g	147	328	g	5.76E-06	2.58E-06	1.15E-06
Benzo(a)anthracene	0.00822	1.000	b	8.22E-03	Regresson	d4	3.84E-03	1.000	b	8.22E-03	0	4.34E-04	0.62	g	1.37	3.07	g	7.06E-04	3.16E-04	1.41E-04
Benzo(a)pyrene	0.00926	1.000	b	9.26E-03	Regresson	d5	1.32E-03	1.000	b	9.26E-03	0	2.11E-04	0.62	g	1.37	3.07	g	3.43E-04	1.54E-04	6.88E-05
Benzo(b)fluoranthene	0.01050	1.000	b	1.05E-02	0.310	d	3.26E-03	1.000	b	1.05E-02	0	4.01E-04	0.62	g	1.37	3.07	g	6.53E-04	2.92E-04	1.31E-04
Benzo(g,h,i)perylene	0.00638	1.000	b	6.38E-03	Regresson	d6	9.97E-04	1.000	b	6.38E-03	0	1.53E-04	0.62	g	1.37	3.07	g	2.49E-04	1.12E-04	4.99E-05
Benzo(k)fluoranthene	0.00422	1.000	b	4.22E-03	Regresson	d7	1.05E-03	1.000	b	4.22E-03	0	1.38E-04	0.62	g	1.37	3.07	g	2.24E-04	1.00E-04	4.48E-05
Chrysene	0.00931	1.000	b	9.31E-03	Regresson	d8	4.14E-03	1.000	b	9.31E-03	0	4.72E-04	0.62	g	1.37	3.07	g	7.67E-04	3.43E-04	1.54E-04
Dibenz(a,h)anthracene	0.00422	1.000	b	4.22E-03	0.130	d	5.49E-04	1.000	b	4.22E-03	0	9.12E-05	0.62	g	1.37	3.07	g	1.48E-04	6.63E-05	2.97E-05
Fluoranthene	0.02560	1.000	b	2.56E-02	0.500	d	1.28E-02	1.000	b	2.56E-02	0	1.43E-03	65.6	g	147	328	g	2.18E-05	9.74E-06	4.35E-06
Fluorene	0.00422	1.000	b	4.22E-03	Regresson	d9	4.13E-01	1.000	b	4.22E-03	0	3.82E-02	65.6	g	147	328	g	5.83E-04	2.61E-04	1.17E-04
Indeno(1,2,3-cd)pyrene	0.00478	1.000	b	4.78E-03	0.110	d	5.26E-04	1.000	b	4.78E-03	0	9.44E-05	0.62	g	1.37	3.07	g	1.54E-04	6.87E-05	3.08E-05
Phenanthrene	0.01370	1.000	b	1.37E-02	Regresson	d10	5.91E-02	1.000	b	1.37E-02	0	5.60E-03	65.6	g	147	328	g	8.53E-05	3.82E-05	1.71E-05
Pyrene	0.01890	1.000	b	1.89E-02	0.720	d	1.36E-02	1.000	b	1.89E-02	0	1.44E-03	0.62	g	1.37	3.07	g	2.34E-03	1.05E-03	4.69E-04

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0765 = Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.906 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.094 = Proportion of diet composed of sediment (Beyer et al. 1994 for raccoon)
WIR = 0.1426 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.750 = Body weight (kg) (USEPA 1993a)

a Bechtel Jacobs 1998b (90th percentile)
b Assumed value
c Bechtel Jacobs 1998a (90th percentile)
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f USEPA 2005c
g USEPA 2007d

Table 8-19b
Summary of Muskrat Exposure Doses - Refined - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	80.8	Regression	a	5.38E+00	Regresson	c	3.11E+00	0.070	e	5.66E+00	0	5.31E-01	4.70	f	6.47	8.90	f	1.13E-01	8.21E-02	5.97E-02
PAHs																				
Acenaphthene	0.00209	1.000	b	2.09E-03	Regresson	d1	7.55E-01	1.000	b	2.09E-03	0	3.49E-02	65.6	g	147	328	g	5.32E-04	2.38E-04	1.06E-04
Acenaphthylene	0.00209	1.000	b	2.09E-03	Regresson	d2	2.41E-03	1.000	b	2.09E-03	0	1.21E-04	65.6	g	147	328	g	1.85E-06	8.28E-07	3.70E-07
Anthracene	0.00244	1.000	b	2.44E-03	Regresson	d3	3.44E-03	1.000	b	2.44E-03	0	1.71E-04	65.6	g	147	328	g	2.60E-06	1.16E-06	5.21E-07
Benzo(a)anthracene	0.00517	1.000	b	5.17E-03	Regresson	d4	2.92E-03	1.000	b	5.17E-03	0	1.59E-04	0.62	g	1.37	3.07	g	2.59E-04	1.16E-04	5.19E-05
Benzo(a)pyrene	0.00569	1.000	b	5.69E-03	Regresson	d5	8.23E-04	1.000	b	5.69E-03	0	6.53E-05	0.62	g	1.37	3.07	g	1.06E-04	4.75E-05	2.13E-05
Benzo(b)fluoranthene	0.00631	1.000	b	6.31E-03	0.310	d	1.95E-03	1.000	b	6.31E-03	0	1.21E-04	0.62	g	1.37	3.07	g	1.96E-04	8.77E-05	3.93E-05
Benzo(g,h,i)perylene	0.00425	1.000	b	4.25E-03	Regresson	d6	6.16E-04	1.000	b	4.25E-03	0	4.88E-05	0.62	g	1.37	3.07	g	7.94E-05	3.55E-05	1.59E-05
Benzo(k)fluoranthene	0.00209	1.000	b	2.09E-03	Regresson	d7	5.74E-04	1.000	b	2.09E-03	0	3.65E-05	0.62	g	1.37	3.07	g	5.93E-05	2.66E-05	1.19E-05
Chrysene	0.00571	1.000	b	5.71E-03	Regresson	d8	3.09E-03	1.000	b	5.71E-03	0	1.70E-04	0.62	g	1.37	3.07	g	2.77E-04	1.24E-04	5.55E-05
Dibenz(a,h)anthracene	0.00209	1.000	b	2.09E-03	0.130	d	2.71E-04	1.000	b	2.09E-03	0	2.25E-05	0.62	g	1.37	3.07	g	3.66E-05	1.64E-05	7.34E-06
Fluoranthene	0.01394	1.000	b	1.39E-02	0.500	d	6.97E-03	1.000	b	1.39E-02	0	3.89E-04	65.6	g	147	328	g	5.93E-06	2.65E-06	1.19E-06
Fluorene	0.00209	1.000	b	2.09E-03	Regresson	d9	7.55E-01	1.000	b	2.09E-03	0	3.49E-02	65.6	g	147	328	g	5.32E-04	2.38E-04	1.06E-04
Indeno(1,2,3-cd)pyrene	0.00345	1.000	b	3.45E-03	0.110	d	3.79E-04	1.000	b	3.45E-03	0	3.40E-05	0.62	g	1.37	3.07	g	5.53E-05	2.48E-05	1.11E-05
Phenanthrene	0.00791	1.000	b	7.91E-03	Regresson	d10	4.20E-02	1.000	b	7.91E-03	0	1.98E-03	65.6	g	147	328	g	3.02E-05	1.35E-05	6.04E-06
Pyrene	0.01051	1.000	b	1.05E-02	0.720	d	7.56E-03	1.000	b	1.05E-02	0	4.00E-04	0.62	g	1.37	3.07	g	6.50E-04	2.91E-04	1.30E-04

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0596 = Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.906 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.094 = Proportion of diet composed of sediment (Beyer et. al 1994 for raccoon)
WIR = 0.1139 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 1.169 = Body weight (kg) (Silva and Downing 1995)

a Bechtel Jacobs 1998b
$Ci = e^{(-0.515 + 0.653(\log Cs))}$
b Assumed value
c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln Cs))}$

d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f USEPA 2005c
g USEPA 2007d

Table 8-20a

Summary of Mallard Exposure Doses - Initial - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	1,130	0.326	a	3.68E+02	0.468	c	5.29E+02	0.070	e	7.91E+01	0	6.24E+01	1.63	f	2.31	3.26	f	3.83E+01	2.71E+01	1.91E+01
PAHs																				
Acenaphthene	0.00422	1.000	b	4.22E-03	Regresson	d1	4.13E-01	1.000	b	4.22E-03	0	4.20E-02	7.10	h	15.9	35.5	g	5.92E-03	2.65E-03	1.18E-03
Acenaphthylene	0.00422	1.000	b	4.22E-03	Regresson	d2	4.21E-03	1.000	b	4.22E-03	0	4.94E-04	7.10	h	15.9	35.5	g	6.95E-05	3.11E-05	1.39E-05
Anthracene	0.00277	1.000	b	2.77E-03	Regresson	d3	3.80E-03	1.000	b	2.77E-03	0	4.29E-04	7.10	h	15.9	35.5	g	6.04E-05	2.70E-05	1.21E-05
Benzo(a)anthracene	0.00822	1.000	b	8.22E-03	Regresson	d4	3.84E-03	1.000	b	8.22E-03	0	5.18E-04	7.10	h	15.9	35.5	g	7.30E-05	3.26E-05	1.46E-05
Benzo(a)pyrene	0.00926	1.000	b	9.26E-03	Regresson	d5	1.32E-03	1.000	b	9.26E-03	0	2.79E-04	7.10	h	15.9	35.5	g	3.93E-05	1.76E-05	7.85E-06
Benzo(b)fluoranthene	0.01050	1.000	b	1.05E-02	0.310	d	3.26E-03	1.000	b	1.05E-02	0	4.94E-04	7.10	h	15.9	35.5	g	6.96E-05	3.11E-05	1.39E-05
Benzo(g,h,i)perylene	0.00638	1.000	b	6.38E-03	Regresson	d6	9.97E-04	1.000	b	6.38E-03	0	2.01E-04	7.10	h	15.9	35.5	g	2.83E-05	1.26E-05	5.65E-06
Benzo(k)fluoranthene	0.00422	1.000	b	4.22E-03	Regresson	d7	1.05E-03	1.000	b	4.22E-03	0	1.73E-04	7.10	h	15.9	35.5	g	2.43E-05	1.09E-05	4.86E-06
Chrysene	0.00931	1.000	b	9.31E-03	Regresson	d8	4.14E-03	1.000	b	9.31E-03	0	5.65E-04	7.10	h	15.9	35.5	g	7.96E-05	3.56E-05	1.59E-05
Dibenz(a,h)anthracene	0.00422	1.000	b	4.22E-03	0.130	d	5.49E-04	1.000	b	4.22E-03	0	1.21E-04	7.10	h	15.9	35.5	g	1.71E-05	7.65E-06	3.42E-06
Fluoranthene	0.02560	1.000	b	2.56E-02	0.500	d	1.28E-02	1.000	b	2.56E-02	0	1.70E-03	7.10	h	15.9	35.5	g	2.39E-04	1.07E-04	4.78E-05
Fluorene	0.00422	1.000	b	4.22E-03	Regresson	d9	4.13E-01	1.000	b	4.22E-03	0	4.20E-02	7.10	h	15.9	35.5	g	5.92E-03	2.65E-03	1.18E-03
Indeno(1,2,3-cd)pyrene	0.00478	1.000	b	4.78E-03	0.110	d	5.26E-04	1.000	b	4.78E-03	0	1.28E-04	7.10	h	15.9	35.5	g	1.80E-05	8.05E-06	3.60E-06
Phenanthrene	0.01370	1.000	b	1.37E-02	Regresson	d10	5.91E-02	1.000	b	1.37E-02	0	6.22E-03	7.10	h	15.9	35.5	g	8.76E-04	3.92E-04	1.75E-04
Pyrene	0.01890	1.000	b	1.89E-02	0.720	d	1.36E-02	1.000	b	1.89E-02	0	1.68E-03	7.10	h	15.9	35.5	g	2.36E-04	1.06E-04	4.72E-05

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI =	Chemical-specific	= Dietary intake for chemical (mg chemical/kg body weight/day)
FIR =	0.0717	= Food ingestion rate (kg/day dry weight) (Nagy 2001)
FCxi =	Chemical-specific	= Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi =	0.100	= Proportion of diet composed of food item (benthic invertebrates) (Palmer 1976)
FCxi =	Chemical-specific	= Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi =	0.867	= Proportion of diet composed of food item (aquatic plants) (Palmer 1976)
FCxi =	Chemical-specific	= Concentration of chemical in food item (fish, dry weight basis)
PDFi =	0.000	= Proportion of diet composed of food item (fish) (Palmer 1976)
SCx =	Chemical-specific	= Concentration of chemical in sediment (mg/kg, dry weight)
PDS =	0.033	= Proportion of diet composed of sediment (Beyer et al. 1994)
WIR =	0.0850	= Water ingestion rate (L/day) (USEPA 1993a)
WC =	Chemical-specific	= Concentration of chemical in water (mg/L)
BW =	0.612	= Body weight (kg) (Belrose 1980)

a Bechtel Jacobs 1998b (90th percentile)

b Assumed value

c Bechtel Jacobs 1998a (90th percentile)

d USEPA 2007e

1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$

3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$

4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$

6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$

7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$

8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$

e Krantzberg and Boyd 1992

f USEPA 2005c

g NOAEL multiplied by 5

h Rigdon and Neal 1963

Table 8-20b
Summary of Mallard Exposure Doses - Refined - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	80.8	Regression	a	5.38E+00	Regresson	c	3.11E+00	0.070	e	5.66E+00	0	2.83E-01	1.63	f	2.31	3.26	f	1.74E-01	1.23E-01	8.68E-02
PAHs																				
Acenaphthene	0.00209	1.000	b	2.09E-03	Regresson	d1	7.55E-01	1.000	b	2.09E-03	0	3.14E-02	7.10	h	15.9	35.5	g	4.42E-03	1.98E-03	8.85E-04
Acenaphthylene	0.00209	1.000	b	2.09E-03	Regresson	d2	2.41E-03	1.000	b	2.09E-03	0	1.14E-04	7.10	h	15.9	35.5	g	1.60E-05	7.15E-06	3.20E-06
Anthracene	0.00244	1.000	b	2.44E-03	Regresson	d3	3.44E-03	1.000	b	2.44E-03	0	1.59E-04	7.10	h	15.9	35.5	g	2.23E-05	9.99E-06	4.47E-06
Benzo(a)anthracene	0.00517	1.000	b	5.17E-03	Regresson	d4	2.92E-03	1.000	b	5.17E-03	0	1.54E-04	7.10	h	15.9	35.5	g	2.17E-05	9.71E-06	4.34E-06
Benzo(a)pyrene	0.00569	1.000	b	5.69E-03	Regresson	d5	8.23E-04	1.000	b	5.69E-03	0	7.05E-05	7.10	h	15.9	35.5	g	9.92E-06	4.44E-06	1.98E-06
Benzo(b)fluoranthene	0.00631	1.000	b	6.31E-03	0.310	d	1.95E-03	1.000	b	6.31E-03	0	1.21E-04	7.10	h	15.9	35.5	g	1.71E-05	7.65E-06	3.42E-06
Benzo(g,h,i)perylene	0.00425	1.000	b	4.25E-03	Regresson	d6	6.16E-04	1.000	b	4.25E-03	0	5.27E-05	7.10	h	15.9	35.5	g	7.42E-06	3.32E-06	1.48E-06
Benzo(k)fluoranthene	0.00209	1.000	b	2.09E-03	Regresson	d7	5.74E-04	1.000	b	2.09E-03	0	3.71E-05	7.10	h	15.9	35.5	g	5.23E-06	2.34E-06	1.05E-06
Chrysene	0.00571	1.000	b	5.71E-03	Regresson	d8	3.09E-03	1.000	b	5.71E-03	0	1.65E-04	7.10	h	15.9	35.5	g	2.32E-05	1.04E-05	4.65E-06
Dibenz(a,h)anthracene	0.00209	1.000	b	2.09E-03	0.130	d	2.71E-04	1.000	b	2.09E-03	0	2.46E-05	7.10	h	15.9	35.5	g	3.46E-06	1.55E-06	6.92E-07
Fluoranthene	0.01394	1.000	b	1.39E-02	0.500	d	6.97E-03	1.000	b	1.39E-02	0	3.79E-04	7.10	h	15.9	35.5	g	5.33E-05	2.38E-05	1.07E-05
Fluorene	0.00209	1.000	b	2.09E-03	Regresson	d9	7.55E-01	1.000	b	2.09E-03	0	3.14E-02	7.10	h	15.9	35.5	g	4.42E-03	1.98E-03	8.85E-04
Indeno(1,2,3-cd)pyrene	0.00345	1.000	b	3.45E-03	0.110	d	3.79E-04	1.000	b	3.45E-03	0	3.77E-05	7.10	h	15.9	35.5	g	5.31E-06	2.38E-06	1.06E-06
Phenanthrene	0.00791	1.000	b	7.91E-03	Regresson	d10	4.20E-02	1.000	b	7.91E-03	0	1.80E-03	7.10	h	15.9	35.5	g	2.53E-04	1.13E-04	5.06E-05
Pyrene	0.01051	1.000	b	1.05E-02	0.720	d	7.56E-03	1.000	b	1.05E-02	0	3.81E-04	7.10	h	15.9	35.5	g	5.37E-05	2.40E-05	1.07E-05

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0564 = Food ingestion rate (kg/day dry weight) (Nagy 2001)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.100 = Proportion of diet composed of food item (benthic invertebrates) (Palmer 1976)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.867 = Proportion of diet composed of food item (aquatic plants) (Palmer 1976)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (fish) (Palmer 1976)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.033 = Proportion of diet composed of sediment (Beyer et al. 1994)
WIR = 0.0658 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 1.177 = Body weight (kg) (Bellrose 1980)

a Bechtel Jacobs 1998b
$C_i = e^{(-0.515 + 0.653(\log Cs))}$
b Assumed value
c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln Cs))}$
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f USEPA 2005c
g NOAEL multiplied by 5
h Rigdon and Neal 1963

Table 8-21a
Summary of Belted Kingfisher Exposure Doses - Initial - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	1,130	0.326	a	3.68E+02	0.468	c	5.29E+02	0.070	e	7.91E+01	0	2.63E+01	3.85	f	8.61	19.3	g	6.82E+00	3.05E+00	1.36E+00
PAHs																				
Acenaphthene	0.00422	1.000	b	4.22E-03	Regresson	d1	4.13E-01	1.000	b	4.22E-03	0	8.84E-04	7.10	h	15.9	35.5	g	1.25E-04	5.57E-05	2.49E-05
Acenaphthylene	0.00422	1.000	b	4.22E-03	Regresson	d2	4.21E-03	1.000	b	4.22E-03	0	8.84E-04	7.10	h	15.9	35.5	g	1.25E-04	5.57E-05	2.49E-05
Anthracene	0.00277	1.000	b	2.77E-03	Regresson	d3	3.80E-03	1.000	b	2.77E-03	0	5.80E-04	7.10	h	15.9	35.5	g	8.17E-05	3.66E-05	1.63E-05
Benzo(a)anthracene	0.00822	1.000	b	8.22E-03	Regresson	d4	3.84E-03	1.000	b	8.22E-03	0	1.72E-03	7.10	h	15.9	35.5	g	2.43E-04	1.08E-04	4.85E-05
Benzo(a)pyrene	0.00926	1.000	b	9.26E-03	Regresson	d5	1.32E-03	1.000	b	9.26E-03	0	1.94E-03	7.10	h	15.9	35.5	g	2.73E-04	1.22E-04	5.46E-05
Benzo(b)fluoranthene	0.01050	1.000	b	1.05E-02	0.310	d	3.26E-03	1.000	b	1.05E-02	0	2.20E-03	7.10	h	15.9	35.5	g	3.10E-04	1.39E-04	6.20E-05
Benzo(g,h,i)perylene	0.00638	1.000	b	6.38E-03	Regresson	d6	9.97E-04	1.000	b	6.38E-03	0	1.34E-03	7.10	h	15.9	35.5	g	1.88E-04	8.42E-05	3.77E-05
Benzo(k)fluoranthene	0.00422	1.000	b	4.22E-03	Regresson	d7	1.05E-03	1.000	b	4.22E-03	0	8.84E-04	7.10	h	15.9	35.5	g	1.25E-04	5.57E-05	2.49E-05
Chrysene	0.00931	1.000	b	9.31E-03	Regresson	d8	4.14E-03	1.000	b	9.31E-03	0	1.95E-03	7.10	h	15.9	35.5	g	2.75E-04	1.23E-04	5.49E-05
Dibenz(a,h)anthracene	0.00422	1.000	b	4.22E-03	0.130	d	5.49E-04	1.000	b	4.22E-03	0	8.84E-04	7.10	h	15.9	35.5	g	1.25E-04	5.57E-05	2.49E-05
Fluoranthene	0.02560	1.000	b	2.56E-02	0.500	d	1.28E-02	1.000	b	2.56E-02	0	5.36E-03	7.10	h	15.9	35.5	g	7.55E-04	3.38E-04	1.51E-04
Fluorene	0.00422	1.000	b	4.22E-03	Regresson	d9	4.13E-01	1.000	b	4.22E-03	0	8.84E-04	7.10	h	15.9	35.5	g	1.25E-04	5.57E-05	2.49E-05
Indeno(1,2,3-cd)pyrene	0.00478	1.000	b	4.78E-03	0.110	d	5.26E-04	1.000	b	4.78E-03	0	1.00E-03	7.10	h	15.9	35.5	g	1.41E-04	6.31E-05	2.82E-05
Phenanthrene	0.01370	1.000	b	1.37E-02	Regresson	d10	5.91E-02	1.000	b	1.37E-02	0	2.87E-03	7.10	h	15.9	35.5	g	4.04E-04	1.81E-04	8.08E-05
Pyrene	0.01890	1.000	b	1.89E-02	0.720	d	1.36E-02	1.000	b	1.89E-02	0	3.96E-03	7.10	h	15.9	35.5	g	5.58E-04	2.49E-04	1.12E-04

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0262 = Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.160 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 0.840 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.000 = Proportion of diet composed of sediment (Sample and Suter 1984)
WIR = 0.0211 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.125 = Body weight (kg) (Dunning 1993)

a Bechtel Jacobs 1998b (90th percentile)
b Assumed value
c Bechtel Jacobs 1998a (90th percentile)
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f Sample et al. 1996
g NOAEL multiplied by 5
h Rigdon and Neal 1963

Table 8-21b
Summary of Belted Kingfisher Exposure Doses - Refined - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	80.8	Regression	a	5.38E+00	Regresson	c	3.11E+00	0.070	e	5.66E+00	0	6.84E-01	3.85	f	8.61	19.3	g	1.78E-01	7.94E-02	3.55E-02
PAHs																				
Acenaphthene	0.00209	1.000	b	2.09E-03	Regresson	d1	7.55E-01	1.000	b	2.09E-03	0	2.54E-04	7.10	h	15.9	35.5	g	3.58E-05	1.60E-05	7.15E-06
Acenaphthylene	0.00209	1.000	b	2.09E-03	Regresson	d2	2.41E-03	1.000	b	2.09E-03	0	2.54E-04	7.10	h	15.9	35.5	g	3.58E-05	1.60E-05	7.15E-06
Anthracene	0.00244	1.000	b	2.44E-03	Regresson	d3	3.44E-03	1.000	b	2.44E-03	0	2.97E-04	7.10	h	15.9	35.5	g	4.19E-05	1.87E-05	8.37E-06
Benzo(a)anthracene	0.00517	1.000	b	5.17E-03	Regresson	d4	2.92E-03	1.000	b	5.17E-03	0	6.29E-04	7.10	h	15.9	35.5	g	8.86E-05	3.96E-05	1.77E-05
Benzo(a)pyrene	0.00569	1.000	b	5.69E-03	Regresson	d5	8.23E-04	1.000	b	5.69E-03	0	6.92E-04	7.10	h	15.9	35.5	g	9.75E-05	4.36E-05	1.95E-05
Benzo(b)fluoranthene	0.00631	1.000	b	6.31E-03	0.310	d	1.95E-03	1.000	b	6.31E-03	0	7.68E-04	7.10	h	15.9	35.5	g	1.08E-04	4.84E-05	2.16E-05
Benzo(g,h,i)perylene	0.00425	1.000	b	4.25E-03	Regresson	d6	6.16E-04	1.000	b	4.25E-03	0	5.17E-04	7.10	h	15.9	35.5	g	7.28E-05	3.26E-05	1.46E-05
Benzo(k)fluoranthene	0.00209	1.000	b	2.09E-03	Regresson	d7	5.74E-04	1.000	b	2.09E-03	0	2.54E-04	7.10	h	15.9	35.5	g	3.58E-05	1.60E-05	7.15E-06
Chrysene	0.00571	1.000	b	5.71E-03	Regresson	d8	3.09E-03	1.000	b	5.71E-03	0	6.95E-04	7.10	h	15.9	35.5	g	9.80E-05	4.38E-05	1.96E-05
Dibenz(a,h)anthracene	0.00209	1.000	b	2.09E-03	0.130	d	2.71E-04	1.000	b	2.09E-03	0	2.54E-04	7.10	h	15.9	35.5	g	3.58E-05	1.60E-05	7.15E-06
Fluoranthene	0.01394	1.000	b	1.39E-02	0.500	d	6.97E-03	1.000	b	1.39E-02	0	1.70E-03	7.10	h	15.9	35.5	g	2.39E-04	1.07E-04	4.78E-05
Fluorene	0.00209	1.000	b	2.09E-03	Regresson	d9	7.55E-01	1.000	b	2.09E-03	0	2.54E-04	7.10	h	15.9	35.5	g	3.58E-05	1.60E-05	7.15E-06
Indeno(1,2,3-cd)pyrene	0.00345	1.000	b	3.45E-03	0.110	d	3.79E-04	1.000	b	3.45E-03	0	4.20E-04	7.10	h	15.9	35.5	g	5.91E-05	2.64E-05	1.18E-05
Phenanthrene	0.00791	1.000	b	7.91E-03	Regresson	d10	4.20E-02	1.000	b	7.91E-03	0	9.63E-04	7.10	h	15.9	35.5	g	1.36E-04	6.06E-05	2.71E-05
Pyrene	0.01051	1.000	b	1.05E-02	0.720	d	7.56E-03	1.000	b	1.05E-02	0	1.28E-03	7.10	h	15.9	35.5	g	1.80E-04	8.06E-05	3.60E-05

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0180 = Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.160 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 0.840 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.000 = Proportion of diet composed of sediment (Sample and Suter 1994)
WIR = 0.0164 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.148 = Body weight (kg) (Dunning 1993)

a Bechtel Jacobs 1998b
$C_i = e^{(-0.515 + 0.653(\log Cs))}$
b Assumed value
c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln Cs))}$
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f Sample et al. 1996
g NOAEL multiplied by 5
h Rigdon and Neal 1963

Table 8-22a

Summary of Great Blue Heron Exposure Doses - Initial - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	1,130	0.326	a	3.68E+02	0.468	c	5.29E+02	0.070	e	7.91E+01	0	5.11E+00	3.85	f	8.61	19.3	g	1.33E+00	5.94E-01	2.65E-01
PAHs																				
Acenaphthene	0.00422	1.000	b	4.22E-03	Regresson	d1	4.13E-01	1.000	b	4.22E-03	0	2.73E-04	7.10	h	15.9	35.5	g	3.84E-05	1.72E-05	7.68E-06
Acenaphthylene	0.00422	1.000	b	4.22E-03	Regresson	d2	4.21E-03	1.000	b	4.22E-03	0	2.73E-04	7.10	h	15.9	35.5	g	3.84E-05	1.72E-05	7.68E-06
Anthracene	0.00277	1.000	b	2.77E-03	Regresson	d3	3.80E-03	1.000	b	2.77E-03	0	1.79E-04	7.10	h	15.9	35.5	g	2.52E-05	1.13E-05	5.04E-06
Benzo(a)anthracene	0.00822	1.000	b	8.22E-03	Regresson	d4	3.84E-03	1.000	b	8.22E-03	0	5.31E-04	7.10	h	15.9	35.5	g	7.48E-05	3.34E-05	1.50E-05
Benzo(a)pyrene	0.00926	1.000	b	9.26E-03	Regresson	d5	1.32E-03	1.000	b	9.26E-03	0	5.98E-04	7.10	h	15.9	35.5	g	8.42E-05	3.77E-05	1.68E-05
Benzo(b)fluoranthene	0.01050	1.000	b	1.05E-02	0.310	d	3.26E-03	1.000	b	1.05E-02	0	6.78E-04	7.10	h	15.9	35.5	g	9.55E-05	4.27E-05	1.91E-05
Benzo(g,h,i)perylene	0.00638	1.000	b	6.38E-03	Regresson	d6	9.97E-04	1.000	b	6.38E-03	0	4.12E-04	7.10	h	15.9	35.5	g	5.80E-05	2.60E-05	1.16E-05
Benzo(k)fluoranthene	0.00422	1.000	b	4.22E-03	Regresson	d7	1.05E-03	1.000	b	4.22E-03	0	2.73E-04	7.10	h	15.9	35.5	g	3.84E-05	1.72E-05	7.68E-06
Chrysene	0.00931	1.000	b	9.31E-03	Regresson	d8	4.14E-03	1.000	b	9.31E-03	0	6.01E-04	7.10	h	15.9	35.5	g	8.47E-05	3.79E-05	1.69E-05
Dibenz(a,h)anthracene	0.00422	1.000	b	4.22E-03	0.130	d	5.49E-04	1.000	b	4.22E-03	0	2.73E-04	7.10	h	15.9	35.5	g	3.84E-05	1.72E-05	7.68E-06
Fluoranthene	0.02560	1.000	b	2.56E-02	0.500	d	1.28E-02	1.000	b	2.56E-02	0	1.65E-03	7.10	h	15.9	35.5	g	2.33E-04	1.04E-04	4.66E-05
Fluorene	0.00422	1.000	b	4.22E-03	Regresson	d9	4.13E-01	1.000	b	4.22E-03	0	2.73E-04	7.10	h	15.9	35.5	g	3.84E-05	1.72E-05	7.68E-06
Indeno(1,2,3-cd)pyrene	0.00478	1.000	b	4.78E-03	0.110	d	5.26E-04	1.000	b	4.78E-03	0	3.09E-04	7.10	h	15.9	35.5	g	4.35E-05	1.94E-05	8.70E-06
Phenanthrene	0.01370	1.000	b	1.37E-02	Regresson	d10	5.91E-02	1.000	b	1.37E-02	0	8.85E-04	7.10	h	15.9	35.5	g	1.25E-04	5.57E-05	2.49E-05
Pyrene	0.01890	1.000	b	1.89E-02	0.720	d	1.36E-02	1.000	b	1.89E-02	0	1.22E-03	7.10	h	15.9	35.5	g	1.72E-04	7.69E-05	3.44E-05

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.1356 = Food ingestion rate (kg/day dry weight) (Nagy 2001)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 1.000 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.000 = Proportion of diet composed of sediment (Sample and Suter 1984)
WIR = 0.1090 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 2.100 = Body weight (kg) (Butler 1992)

a Bechtel Jacobs 1998b (90th percentile)
b Assumed value
c Bechtel Jacobs 1998a (90th percentile)
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f Sample et al. 1996
g NOAEL multiplied by 5
h Rigdon and Neal 1963

Table 8-22b
Summary of Great Blue Heron Exposure Doses - Refined - Skeet and Trap Range
Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	80.8	Regression	a	5.38E+00	Regresson	c	3.11E+00	0.070	e	5.66E+00	0	3.18E-01	3.85	f	8.61	19.3	g	8.26E-02	3.70E-02	1.65E-02
PAHs																				
Acenaphthene	0.00209	1.000	b	2.09E-03	Regresson	d1	7.55E-01	1.000	b	2.09E-03	0	1.17E-04	7.10	h	15.9	35.5	g	1.65E-05	7.39E-06	3.30E-06
Acenaphthylene	0.00209	1.000	b	2.09E-03	Regresson	d2	2.41E-03	1.000	b	2.09E-03	0	1.17E-04	7.10	h	15.9	35.5	g	1.65E-05	7.39E-06	3.30E-06
Anthracene	0.00244	1.000	b	2.44E-03	Regresson	d3	3.44E-03	1.000	b	2.44E-03	0	1.37E-04	7.10	h	15.9	35.5	g	1.93E-05	8.64E-06	3.87E-06
Benzo(a)anthracene	0.00517	1.000	b	5.17E-03	Regresson	d4	2.92E-03	1.000	b	5.17E-03	0	2.91E-04	7.10	h	15.9	35.5	g	4.09E-05	1.83E-05	8.18E-06
Benzo(a)pyrene	0.00569	1.000	b	5.69E-03	Regresson	d5	8.23E-04	1.000	b	5.69E-03	0	3.20E-04	7.10	h	15.9	35.5	g	4.50E-05	2.01E-05	9.01E-06
Benzo(b)fluoranthene	0.00631	1.000	b	6.31E-03	0.310	d	1.95E-03	1.000	b	6.31E-03	0	3.55E-04	7.10	h	15.9	35.5	g	4.99E-05	2.23E-05	9.99E-06
Benzo(g,h,i)perylene	0.00425	1.000	b	4.25E-03	Regresson	d6	6.16E-04	1.000	b	4.25E-03	0	2.39E-04	7.10	h	15.9	35.5	g	3.36E-05	1.50E-05	6.73E-06
Benzo(k)fluoranthene	0.00209	1.000	b	2.09E-03	Regresson	d7	5.74E-04	1.000	b	2.09E-03	0	1.17E-04	7.10	h	15.9	35.5	g	1.65E-05	7.39E-06	3.30E-06
Chrysene	0.00571	1.000	b	5.71E-03	Regresson	d8	3.09E-03	1.000	b	5.71E-03	0	3.21E-04	7.10	h	15.9	35.5	g	4.52E-05	2.02E-05	9.05E-06
Dibenz(a,h)anthracene	0.00209	1.000	b	2.09E-03	0.130	d	2.71E-04	1.000	b	2.09E-03	0	1.17E-04	7.10	h	15.9	35.5	g	1.65E-05	7.39E-06	3.30E-06
Fluoranthene	0.01394	1.000	b	1.39E-02	0.500	d	6.97E-03	1.000	b	1.39E-02	0	7.84E-04	7.10	h	15.9	35.5	g	1.10E-04	4.94E-05	2.21E-05
Fluorene	0.00209	1.000	b	2.09E-03	Regresson	d9	7.55E-01	1.000	b	2.09E-03	0	1.17E-04	7.10	h	15.9	35.5	g	1.65E-05	7.39E-06	3.30E-06
Indeno(1,2,3-cd)pyrene	0.00345	1.000	b	3.45E-03	0.110	d	3.79E-04	1.000	b	3.45E-03	0	1.94E-04	7.10	h	15.9	35.5	g	2.73E-05	1.22E-05	5.46E-06
Phenanthrene	0.00791	1.000	b	7.91E-03	Regresson	d10	4.20E-02	1.000	b	7.91E-03	0	4.45E-04	7.10	h	15.9	35.5	g	6.26E-05	2.80E-05	1.25E-05
Pyrene	0.01051	1.000	b	1.05E-02	0.720	d	7.56E-03	1.000	b	1.05E-02	0	5.91E-04	7.10	h	15.9	35.5	g	8.32E-05	3.72E-05	1.66E-05

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.1254 = Food ingestion rate (kg/day dry weight) (Nagy 2001)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 1.000 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.000 = Proportion of diet composed of sediment (Sample and Suter 1994)
WIR = 0.1010 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 2.230 = Body weight (kg) (Quinney 1982)

a Bechtel Jacobs 1998b
$Ci = e^{(-0.515 + 0.653(\log Cs))}$
b Assumed value
c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln Cs))}$
d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f Sample et al. 1996
g NOAEL multiplied by 5
h Rigdon and Neal 1963

Table 8-23a

Summary of Marsh Wren Exposure Doses - Initial - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Maximum Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Maximum Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	1,130	0.326	a	3.68E+02	0.468	c	5.29E+02	0.070	e	7.91E+01	0	1.24E+02	3.85	f	8.61	19.3	g	3.23E+01	1.44E+01	6.46E+00
PAHs																				
Acenaphthene	0.00422	1.000	b	4.22E-03	Regresson	d1	4.13E-01	1.000	b	4.22E-03	0	1.29E-03	7.10	h	15.9	35.5	g	1.82E-04	8.13E-05	3.64E-05
Acenaphthylene	0.00422	1.000	b	4.22E-03	Regresson	d2	4.21E-03	1.000	b	4.22E-03	0	1.29E-03	7.10	h	15.9	35.5	g	1.82E-04	8.13E-05	3.64E-05
Anthracene	0.00277	1.000	b	2.77E-03	Regresson	d3	3.80E-03	1.000	b	2.77E-03	0	8.48E-04	7.10	h	15.9	35.5	g	1.19E-04	5.34E-05	2.39E-05
Benzo(a)anthracene	0.00822	1.000	b	8.22E-03	Regresson	d4	3.84E-03	1.000	b	8.22E-03	0	2.52E-03	7.10	h	15.9	35.5	g	3.54E-04	1.58E-04	7.09E-05
Benzo(a)pyrene	0.00926	1.000	b	9.26E-03	Regresson	d5	1.32E-03	1.000	b	9.26E-03	0	2.83E-03	7.10	h	15.9	35.5	g	3.99E-04	1.78E-04	7.98E-05
Benzo(b)fluoranthene	0.01050	1.000	b	1.05E-02	0.310	d	3.26E-03	1.000	b	1.05E-02	0	3.21E-03	7.10	h	15.9	35.5	g	4.53E-04	2.02E-04	9.05E-05
Benzo(g,h,i)perylene	0.00638	1.000	b	6.38E-03	Regresson	d6	9.97E-04	1.000	b	6.38E-03	0	1.95E-03	7.10	h	15.9	35.5	g	2.75E-04	1.23E-04	5.50E-05
Benzo(k)fluoranthene	0.00422	1.000	b	4.22E-03	Regresson	d7	1.05E-03	1.000	b	4.22E-03	0	1.29E-03	7.10	h	15.9	35.5	g	1.82E-04	8.13E-05	3.64E-05
Chrysene	0.00931	1.000	b	9.31E-03	Regresson	d8	4.14E-03	1.000	b	9.31E-03	0	2.85E-03	7.10	h	15.9	35.5	g	4.01E-04	1.79E-04	8.02E-05
Dibenz(a,h)anthracene	0.00422	1.000	b	4.22E-03	0.130	d	5.49E-04	1.000	b	4.22E-03	0	1.29E-03	7.10	h	15.9	35.5	g	1.82E-04	8.13E-05	3.64E-05
Fluoranthene	0.02560	1.000	b	2.56E-02	0.500	d	1.28E-02	1.000	b	2.56E-02	0	7.83E-03	7.10	h	15.9	35.5	g	1.10E-03	4.93E-04	2.21E-04
Fluorene	0.00422	1.000	b	4.22E-03	Regresson	d9	4.13E-01	1.000	b	4.22E-03	0	1.29E-03	7.10	h	15.9	35.5	g	1.82E-04	8.13E-05	3.64E-05
Indeno(1,2,3-cd)pyrene	0.00478	1.000	b	4.78E-03	0.110	d	5.26E-04	1.000	b	4.78E-03	0	1.46E-03	7.10	h	15.9	35.5	g	2.06E-04	9.21E-05	4.12E-05
Phenanthrene	0.01370	1.000	b	1.37E-02	Regresson	d10	5.91E-02	1.000	b	1.37E-02	0	4.19E-03	7.10	h	15.9	35.5	g	5.90E-04	2.64E-04	1.18E-04
Pyrene	0.01890	1.000	b	1.89E-02	0.720	d	1.36E-02	1.000	b	1.89E-02	0	5.78E-03	7.10	h	15.9	35.5	g	8.15E-04	3.64E-04	1.63E-04

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI =	Chemical-specific	= Dietary intake for chemical (mg chemical/kg body weight/day)
FIR =	0.0030	= Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi =	Chemical-specific	= Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi =	0.950	= Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi =	Chemical-specific	= Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi =	0.000	= Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi =	Chemical-specific	= Concentration of chemical in food item (fish, dry weight basis)
PDFi =	0.000	= Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx =	Chemical-specific	= Concentration of chemical in sediment (mg/kg, dry weight)
PDS =	0.050	= Proportion of diet composed of sediment (assumed based upon diet)
WIR =	0.0033	= Water ingestion rate (L/day) (USEPA 1993a)
WC =	Chemical-specific	= Concentration of chemical in water (mg/L)
BW =	0.00975	= Body weight (kg) (Dunning 1993)

a Bechtel Jacobs 1998b (90th percentile)

b Assumed value

c Bechtel Jacobs 1998a (90th percentile)

d USEPA 2007e

1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$

3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$

4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$

6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$

7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$

8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$

9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$

10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$

e Krantzberg and Boyd 1992

f Sample et al. 1996

g NOAEL multiplied by 5

h Rigdon and Neal 1963

Table 8-23b

Summary of Marsh Wren Exposure Doses - Refined - Skeet and Trap Range

Fleet Combat Training Center - Dam Neck Annex

Chemical	Mean Sediment Concentration (mg/kg)	Sediment-Invertebrate BAF		Benthic Invertebrate Concentration (mg/kg dw)	Sediment-Plant BAF		Aquatic Plant Concentration (mg/kg dw)	Sediment-Fish BAF		Fish Concentration (mg/kg dw)	Mean Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/day)	NOAEL TRV (mg/kg/d)		MATC TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)		NOAEL HQ	MATC HQ	LOAEL HQ
Metals																				
Lead	80.8	Regression	a	5.38E+00	Regresson	c	3.11E+00	0.070	e	5.66E+00	0	2.02E+00	3.85	f	8.61	19.3	g	5.25E-01	2.35E-01	1.05E-01
PAHs																				
Acenaphthene	0.00209	1.000	b	2.09E-03	Regresson	d1	7.55E-01	1.000	b	2.09E-03	0	4.61E-04	7.10	h	15.9	35.5	g	6.49E-05	2.90E-05	1.30E-05
Acenaphthylene	0.00209	1.000	b	2.09E-03	Regresson	d2	2.41E-03	1.000	b	2.09E-03	0	4.61E-04	7.10	h	15.9	35.5	g	6.49E-05	2.90E-05	1.30E-05
Anthracene	0.00244	1.000	b	2.44E-03	Regresson	d3	3.44E-03	1.000	b	2.44E-03	0	5.39E-04	7.10	h	15.9	35.5	g	7.59E-05	3.40E-05	1.52E-05
Benzo(a)anthracene	0.00517	1.000	b	5.17E-03	Regresson	d4	2.92E-03	1.000	b	5.17E-03	0	1.14E-03	7.10	h	15.9	35.5	g	1.61E-04	7.19E-05	3.22E-05
Benzo(a)pyrene	0.00569	1.000	b	5.69E-03	Regresson	d5	8.23E-04	1.000	b	5.69E-03	0	1.26E-03	7.10	h	15.9	35.5	g	1.77E-04	7.91E-05	3.54E-05
Benzo(b)fluoranthene	0.00631	1.000	b	6.31E-03	0.310	d	1.95E-03	1.000	b	6.31E-03	0	1.39E-03	7.10	h	15.9	35.5	g	1.96E-04	8.78E-05	3.93E-05
Benzo(g,h,i)perylene	0.00425	1.000	b	4.25E-03	Regresson	d6	6.16E-04	1.000	b	4.25E-03	0	9.38E-04	7.10	h	15.9	35.5	g	1.32E-04	5.91E-05	2.64E-05
Benzo(k)fluoranthene	0.00209	1.000	b	2.09E-03	Regresson	d7	5.74E-04	1.000	b	2.09E-03	0	4.61E-04	7.10	h	15.9	35.5	g	6.49E-05	2.90E-05	1.30E-05
Chrysene	0.00571	1.000	b	5.71E-03	Regresson	d8	3.09E-03	1.000	b	5.71E-03	0	1.26E-03	7.10	h	15.9	35.5	g	1.78E-04	7.95E-05	3.55E-05
Dibenz(a,h)anthracene	0.00209	1.000	b	2.09E-03	0.130	d	2.71E-04	1.000	b	2.09E-03	0	4.61E-04	7.10	h	15.9	35.5	g	6.49E-05	2.90E-05	1.30E-05
Fluoranthene	0.01394	1.000	b	1.39E-02	0.500	d	6.97E-03	1.000	b	1.39E-02	0	3.08E-03	7.10	h	15.9	35.5	g	4.34E-04	1.94E-04	8.68E-05
Fluorene	0.00209	1.000	b	2.09E-03	Regresson	d9	7.55E-01	1.000	b	2.09E-03	0	4.61E-04	7.10	h	15.9	35.5	g	6.49E-05	2.90E-05	1.30E-05
Indeno(1,2,3-cd)pyrene	0.00345	1.000	b	3.45E-03	0.110	d	3.79E-04	1.000	b	3.45E-03	0	7.61E-04	7.10	h	15.9	35.5	g	1.07E-04	4.80E-05	2.14E-05
Phenanthrene	0.00791	1.000	b	7.91E-03	Regresson	d10	4.20E-02	1.000	b	7.91E-03	0	1.75E-03	7.10	h	15.9	35.5	g	2.46E-04	1.10E-04	4.92E-05
Pyrene	0.01051	1.000	b	1.05E-02	0.720	d	7.56E-03	1.000	b	1.05E-02	0	2.32E-03	7.10	h	15.9	35.5	g	3.27E-04	1.46E-04	6.54E-05

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
FIR = 0.0025 = Food ingestion rate (kg/day dry weight) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (benthic invertebrates, dry weight basis)
PDFi = 0.950 = Proportion of diet composed of food item (benthic invertebrates) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (aquatic plants, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (aquatic plants) (USEPA 1993a)
FCxi = Chemical-specific = Concentration of chemical in food item (fish, dry weight basis)
PDFi = 0.000 = Proportion of diet composed of food item (fish) (USEPA 1993a)
SCx = Chemical-specific = Concentration of chemical in sediment (mg/kg, dry weight)
PDS = 0.050 = Proportion of diet composed of sediment (assumed based upon diet)
WIR = 0.0029 = Water ingestion rate (L/day) (USEPA 1993a)
WC = Chemical-specific = Concentration of chemical in water (mg/L)
BW = 0.01125 = Body weight (kg) (Dunning 1993)

a Bechtel Jacobs 1998b
$Ci = e^{(-0.515 + 0.653(\log Cs))}$
b Assumed value
c Bechtel Jacobs 1998a
$C_n = e^{(-1.328 + 0.561(\ln Cs))}$

d USEPA 2007e
1 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
2 $C_n = e^{(-1.144 + 0.791(\ln Cs))}$
3 $C_n = e^{(-0.9887 + 0.7784(\ln Cs))}$
4 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
5 $C_n = e^{(-2.0615 + 0.9750(\ln Cs))}$
6 $C_n = e^{(-0.9313 + 1.1829(\ln Cs))}$
7 $C_n = e^{(-2.1579 + 0.8595(\ln Cs))}$
8 $C_n = e^{(-2.7078 + 0.5944(\ln Cs))}$
9 $C_n = e^{(-5.562 - 0.8556(\ln Cs))}$
10 $C_n = e^{(-0.1665 + 0.6203(\ln Cs))}$
e Krantzberg and Boyd 1992
f Sample et al. 1996
g NOAEL multiplied by 5
h Rigdon and Neal 1963

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\DAMNECK\SI REPORT\REVISED\FIGURE8-1_SKEETTRAP_SAMPLES.MXD MARTESE 10/7/2011 10:14:16 AM

Legend

May 2011 Sampling Event (DNSTR-)
- Sediment Sampling Locations (0-12") - Lead Analysis
- Sediment Sampling Locations (0-6") - Lead and PAH Analysis
- Soil Sampling Locations (0-6") - PAH Analysis

June 2010 Sampling Event (DNSTR-)
- Soil Sampling Locations (0-6") - Lead Analysis
- Soil Sampling Locations (0-6") - Lead and PAH Analysis
- Firing Point (Skeet)
- Firing Point (Trap)

- MRP Site
- Skeet: area of likeliest munitions constituents (shotfall)
- Trap: area of likeliest munitions constituents (shotfall)

0 225 450 Feet

N W E S

Figure 8-1
Skeet and Trap Range Sample Locations
Former Small Arms Firing Ranges
Revised Site Inspection Report
Dam Neck Annex, NAS Oceana
Virginia Beach, Virginia

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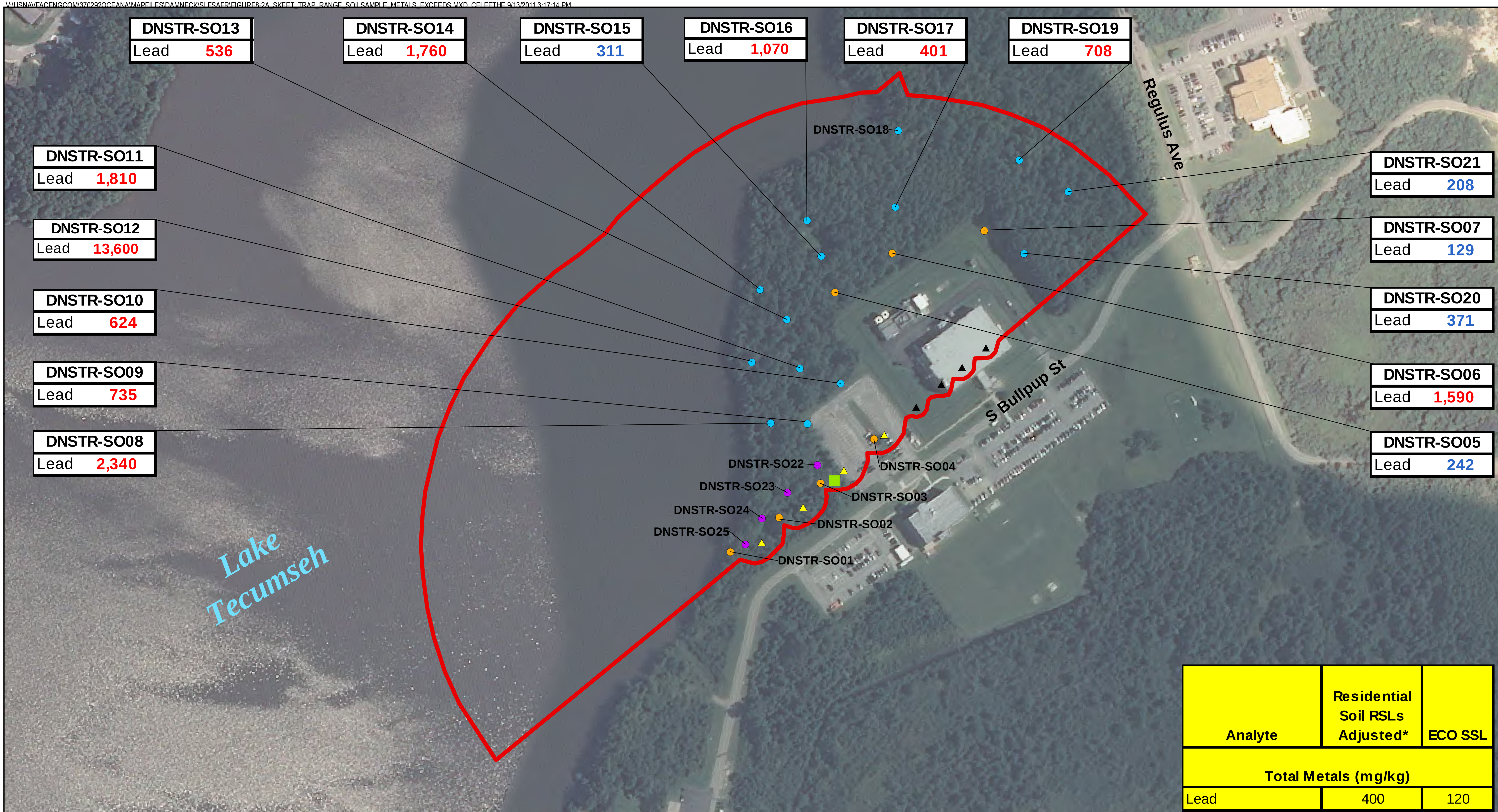

Analyte	Residential Soil RSLs Adjusted*	ECO SSL
Total Metals (mg/kg)		
Lead	400	120

Legend

- Soil Sampling Location (0-6") - Lead analysis
- Soil Sampling Location (0-6") - Lead and PAH analysis
- Soil Sampling Location (0-6") - PAH analysis
- Skeet Shed Structure
- Firing Point (Skeet)
- Firing Point (Trap)
- MRP Site

NOTES:

Concentrations shown in **green** exceed the USEPA residential soil regional screening levels
Concentrations shown in **blue** exceed the ecological soil screening levels
Concentrations shown in **red** exceed both the ecological and residential screening levels
All results are shown in milligrams per kilogram (mg/kg)

N
W E
S

0 300 600
Feet

Figure 8-2a
Skeet and Trap Range Soil Metals Exceedances
Former Small Arms Firing Ranges
Revised Site Inspection Report
Dam Neck Annex, NAS Oceana
Virginia Beach, Virginia

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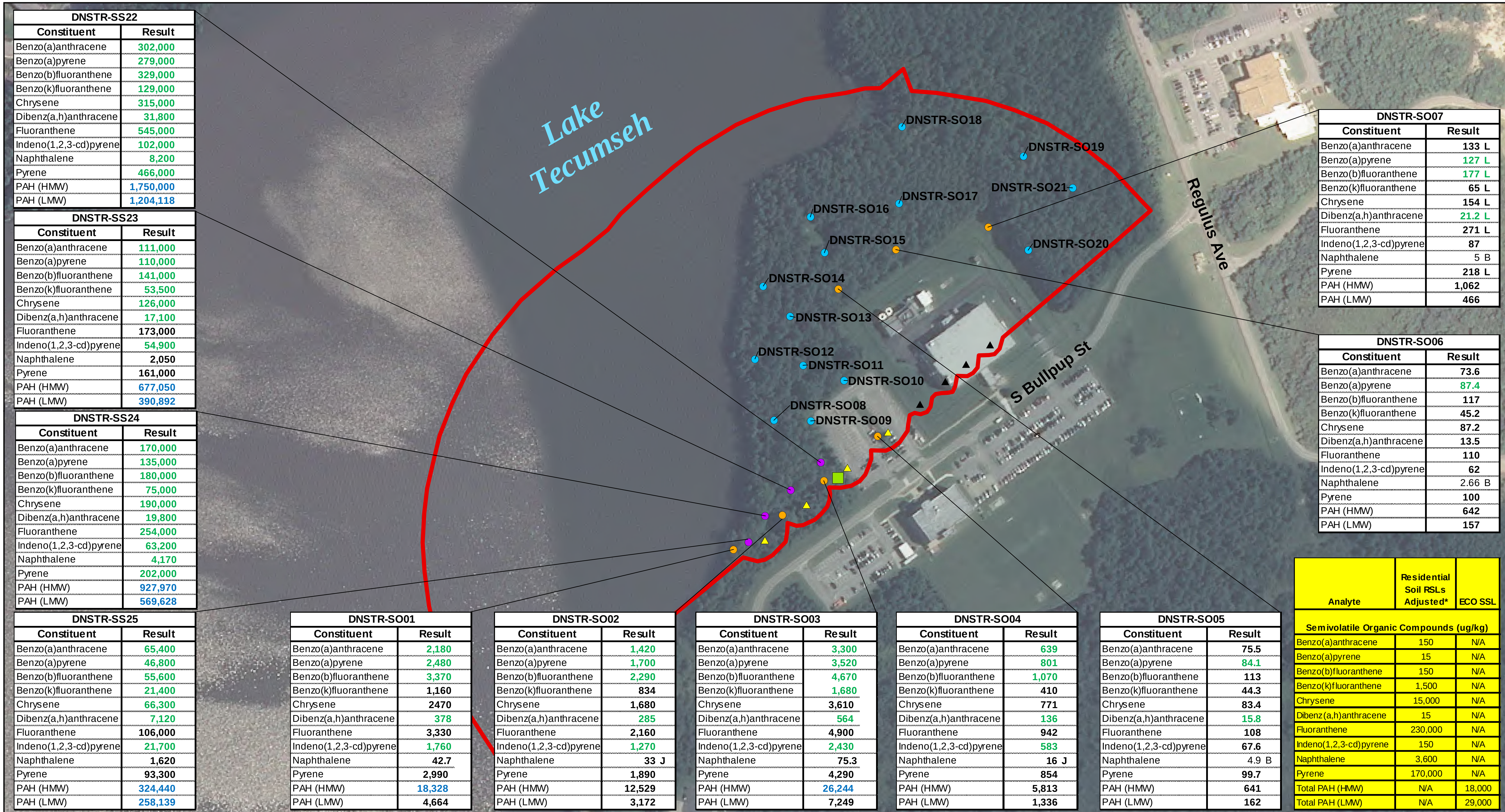

DNSTR-SS22	
Constituent	Result
Benzo(a)anthracene	302,000
Benzo(a)pyrene	279,000
Benzo(b)fluoranthene	329,000
Benzo(k)fluoranthene	129,000
Chrysene	315,000
Dibenz(a,h)anthracene	31,800
Fluoranthene	545,000
Indeno(1,2,3-cd)pyrene	102,000
Naphthalene	8,200
Pyrene	466,000
PAH (HMW)	1,750,000
PAH (LMW)	1,204,118

DNSTR-SS23	
Constituent	Result
Benzo(a)anthracene	111,000
Benzo(a)pyrene	110,000
Benzo(b)fluoranthene	141,000
Benzo(k)fluoranthene	53,500
Chrysene	126,000
Dibenz(a,h)anthracene	17,100
Fluoranthene	173,000
Indeno(1,2,3-cd)pyrene	54,900
Naphthalene	2,050
Pyrene	161,000
PAH (HMW)	677,050
PAH (LMW)	390,892

DNSTR-SS24	
Constituent	Result
Benzo(a)anthracene	170,000
Benzo(a)pyrene	135,000
Benzo(b)fluoranthene	180,000
Benzo(k)fluoranthene	75,000
Chrysene	190,000
Dibenz(a,h)anthracene	19,800
Fluoranthene	254,000
Indeno(1,2,3-cd)pyrene	63,200
Naphthalene	4,170
Pyrene	202,000
PAH (HMW)	927,970
PAH (LMW)	569,628

DNSTR-SS25	
Constituent	Result
Benzo(a)anthracene	65,400
Benzo(a)pyrene	46,800
Benzo(b)fluoranthene	55,600
Benzo(k)fluoranthene	21,400
Chrysene	66,300
Dibenz(a,h)anthracene	7,120
Fluoranthene	106,000
Indeno(1,2,3-cd)pyrene	21,700
Naphthalene	1,620
Pyrene	93,300
PAH (HMW)	324,440
PAH (LMW)	258,139

DNSTR-SO01	
Constituent	Result
Benzo(a)anthracene	2,180
Benzo(a)pyrene	2,480
Benzo(b)fluoranthene	3,370
Benzo(k)fluoranthene	1,160
Chrysene	2470
Dibenz(a,h)anthracene	378
Fluoranthene	3,330
Indeno(1,2,3-cd)pyrene	1,760
Naphthalene	42.7
Pyrene	2,990
PAH (HMW)	18,328
PAH (LMW)	4,664

DNSTR-SO02	
Constituent	Result
Benzo(a)anthracene	1,420
Benzo(a)pyrene	1,700
Benzo(b)fluoranthene	2,290
Benzo(k)fluoranthene	834
Chrysene	1,680
Dibenz(a,h)anthracene	285
Fluoranthene	2,160
Indeno(1,2,3-cd)pyrene	1,270
Naphthalene	33 J
Pyrene	1,890
PAH (HMW)	12,529
PAH (LMW)	3,172

DNSTR-SO03	
Constituent	Result
Benzo(a)anthracene	3,300
Benzo(a)pyrene	3,520
Benzo(b)fluoranthene	4,670
Benzo(k)fluoranthene	1,680
Chrysene	3,610
Dibenz(a,h)anthracene	564
Fluoranthene	4,900
Indeno(1,2,3-cd)pyrene	2,430
Naphthalene	75.3
Pyrene	4,290
PAH (HMW)	26,244
PAH (LMW)	7,249

DNSTR-SO04	
Constituent	Result
Benzo(a)anthracene	639
Benzo(a)pyrene	801
Benzo(b)fluoranthene	1,070
Benzo(k)fluoranthene	410
Chrysene	771
Dibenz(a,h)anthracene	136
Fluoranthene	942
Indeno(1,2,3-cd)pyrene	583
Naphthalene	16 J
Pyrene	854
PAH (HMW)	5,813
PAH (LMW)	1,336

DNSTR-SO05	
Constituent	Result
Benzo(a)anthracene	75.5
Benzo(a)pyrene	84.1
Benzo(b)fluoranthene	113
Benzo(k)fluoranthene	44.3
Chrysene	83.4
Dibenz(a,h)anthracene	15.8
Fluoranthene	108
Indeno(1,2,3-cd)pyrene	67.6
Naphthalene	4.9 B
Pyrene	99.7
PAH (HMW)	641
PAH (LMW)	162

DNSTR-SO07	
Constituent	Result
Benzo(a)anthracene	133 L
Benzo(a)pyrene	127 L
Benzo(b)fluoranthene	177 L
Benzo(k)fluoranthene	65 L
Chrysene	154 L
Dibenz(a,h)anthracene	21.2 L
Fluoranthene	271 L
Indeno(1,2,3-cd)pyrene	87
Naphthalene	5 B
Pyrene	218 L
PAH (HMW)	1,062
PAH (LMW)	466

DNSTR-SO06	
Constituent	Result
Benzo(a)anthracene	73.6
Benzo(a)pyrene	87.4
Benzo(b)fluoranthene	117
Benzo(k)fluoranthene	45.2
Chrysene	87.2
Dibenz(a,h)anthracene	13.5
Fluoranthene	110
Indeno(1,2,3-cd)pyrene	62
Naphthalene	2.66 B
Pyrene	100
PAH (HMW)	642
PAH (LMW)	157

Analyte	Residential Soil RSLs Adjusted*	ECO SSL
Semivolatile Organic Compounds (ug/kg)		
Benzo(a)anthracene	150	N/A
Benzo(a)pyrene	15	N/A
Benzo(b)fluoranthene	150	N/A
Benzo(k)fluoranthene	1,500	N/A
Chrysene	15,000	N/A
Dibenz(a,h)anthracene	15	N/A
Fluoranthene	230,000	N/A
Indeno(1,2,3-cd)pyrene	150	N/A
Naphthalene	3,600	N/A
Pyrene	170,000	N/A
Total PAH (HMW)	N/A	18,000
Total PAH (LMW)	N/A	29,000

Legend

- Soil Sampling Location (0-6") - PAH analysis
- Soil Sampling Location (0-6") - Lead analysis
- Soil Sampling Location (0-6") - Lead and PAH analysis
- Skeet Shed Structure
- Firing Point (Skeet)
- Firing Point (Trap)
- MRP Site

NOTES:

Concentrations shown in green exceed the USEPA residential soil regional screening levels
Concentrations shown in blue exceed the ecological soil screening levels
Concentrations shown in red exceed both the ecological and residential screening levels
All results are shown in milligrams per kilogram (mg/kg)

N
W E
S

0 300 600
Feet

Figure 8-2b
Skeet and Trap Range Soil PAHs Exceedances
Former Small Arms Firing Ranges
Revised Site Inspection Report
Dam Neck Annex, NAS Oceana
Virginia Beach, Virginia

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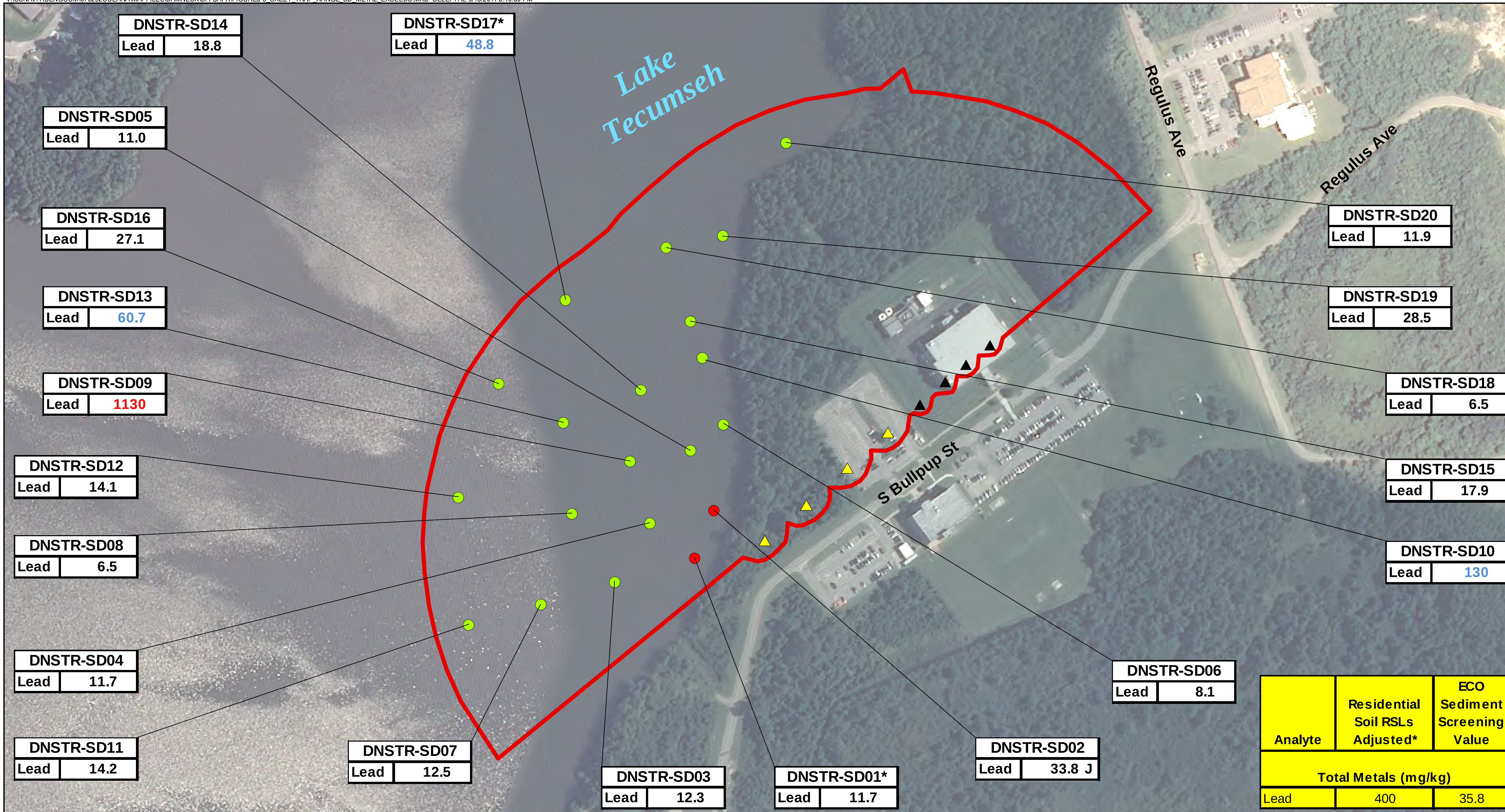
V:\USNAVFACENGCOM\370292OCEANA\MAPFILES\DAMNECK\SI FSAFR\FIGURE8-3_SKEET_TRAP_RANGE_SD_METAL_EXCEEDS.MXD CELEFTHE 9/15/2011 3:40:56 PM



Legend

- Sediment Sampling Location (0-6") - Lead Analysis
- Sediment Sampling Location (0-6") - Lead and PAH Analysis
- Firing Point (Skeet)
- Firing Point (Trap)
- MRP Site

NOTES:

Concentrations shown in green exceed the USEPA residential soil regional screening levels
Concentrations shown in blue exceed the ecological soil screening levels
Concentrations shown in red exceed both the ecological and residential screening levels
All results are shown in milligrams per kilogram (mg/kg)
* - Duplicate sample location, more conservative value presented

N W E S

0 250 500 Feet

Figure 8-3
Skeet and Trap Range Sediment Metals Exceedances
Former Small Arms Firing Ranges
Revised Site Inspection Report
Dam Neck Annex, NAS Oceana
Virginia Beach, Virginia

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SECTION 9

NALF Fentress: Machine Gun Boresight Range

9.1 Site Background

The former Machine Gun Boresight Range at NALF Fentress encompasses about 1 acre and lies southwest of runway 1-19, on the northern portion of the facility (**Figure 9-1**). The former Machine Gun Boresight Range is oriented northeast-southwest, with the former firing point at the northernmost end, as indicated on a 1955 archival map. The southwestern half of the site is overgrown with brush and trees, while the northeastern half is generally flat and consists of maintained grass along the border of an active aircraft runway. The site was initially used as a maintenance and testing range for aircraft-mounted machine guns, but was later converted to a pistol range, as shown on a 1974 archival map (Malcolm Pirnie, 2008). A concrete backstop is still in place on the southwestern portion and is showing signs of deterioration. Although there are no water bodies on the site, shrub wetlands are located within the site boundaries. The range backstop and the northeastern half of the site, consisting of maintained grass, are not located in a wetland area.

Ammunition used at the former Machine Gun Boresight Range was likely limited to .50 and .30 caliber rounds for aircraft guns. Additionally, expended 7-mm, 9-mm, .38 and .30 caliber, and shotgun rounds were observed at the site during a site reconnaissance by Malcolm Pirnie in 2007 (Malcolm Pirnie, 2008) and by CH2M HILL in 2009; however, the additional rounds appeared to be from more-recent, recreational use. Potential MC associated with these types of ammunition are composed of lead, antimony, arsenic, copper, nickel, and zinc (Malcolm Pirnie, 2008). Based on the nature of the munitions likely to have been used onsite, the potential source of contamination is suspected to be within the top 24 inches of the surface. Although the distribution of small arms ammunition debris within the former range is not known, it is suspected that the greatest density would be present in the backstop.

9.2 Rationale for Investigation

Potential sources of contamination present at the former range are debris related to small arms firing range ammunition. It was concluded that surface and subsurface soils are the most likely media to be contaminated, based on the use of the range. Because groundwater in this area is not anticipated to be affected, the SI did not evaluate groundwater as a potential route of exposure. There is no surface water or sediment present onsite.

9.3 Field Activities

9.3.1 Visual and Metal Detector Surveys

During the sampling event, the sampling area was visually inspected, as described in Section 3.2.

During the inspection, .223 caliber small arms projectiles and jackets, .45-caliber cartridges, .30 caliber machine gun rounds, 9-mm pistol, and shotgun rounds and were found on the ground surface of the entire berm. The .223 projectiles and 9-mm shotgun rounds appeared to be from recent use. The .30 caliber machine gun rounds and .45 caliber cartridges appeared to be older based on the amount of deterioration. Significant bullet scarring was observed across the length of the backstop.

A metal detector survey was not completed at the site because metallic debris was visually identified across the ground surface of the berm and a metal detector was not necessary.

9.3.2 Sample Collection

Discrete surface and subsurface soil samples were collected from eight locations from the berm of the backstop, as shown on **Figure 9-1.** Since the entire berm appeared to be impacted by range activities, sample locations were equally distributed across the anticipated contaminated area. Subsurface samples were dug following the trajectory of the bullet (horizontally) into the berm instead of vertically. Samples were analyzed for lead, antimony, arsenic, copper, nickel, and zinc.

9.4 Release Assessment Decision Analysis

Data for the samples collected during the field investigations were evaluated in accordance with the decision logic presented on **Figure 3-1** and approved by the project team during development of the UFP-SAP (CH2M HILL, 2010). The following subsections describe the steps in the decision process, analytical results, and an evaluation of potential risks at this former range.

Table 9-1 presents an exceedance summary of the sample results. **Table 9-2**, presented at the end of this section, contains the validated analytical results of the sample investigation. The results were compared to RSLs for residential soil and Eco-SSLs for plants and soil invertebrates, as described in Sections 3.8 and 3.9. The exceedance results are presented on **Figure 9-2**.

Sections 9.4.1 through 9.4.3 summarize the results associated with each step of the decision analysis.

TABLE 9-1
Machine Gun Boresight Range Exceedances

Total Number of Samples	Analyte	Units	Max Value	Residential Soil RSL	Number of Residential Soil RSL Exceedances	ECO-SSL	Number of ECO-SSL Exceedances
8 (SS)	Antimony	mg/kg	22	3.1	4/8	78	0/8
	Arsenic	mg/kg	4.59	0.39	8/8	18	0/8
	Copper	mg/kg	68,400	310	4/8	70	8/8
	Lead	mg/kg	17,100	400	7/8	120	8/8
	Nickel	mg/kg	12	150	0/8	38	0/8
	Zinc	mg/kg	6,290	2,400	1/8	120	1/8
8 (SB)	Antimony	mg/kg	22.1	3.1	2/8	78	0/8
	Arsenic	mg/kg	5.53	0.39	8/8	18	0/8
	Copper	mg/kg	556	310	2/8	70	5/8
	Lead	mg/kg	8,970	400	6/8	120	6/8
	Nickel	mg/kg	12	150	0/8	38	0/8
	Zinc	mg/kg	198	2,400	0/8	120	1/8

9.4.1 Step 1

Eight surface and eight subsurface samples were collected from each of the eight sampling locations at the Machine Gun Boresight Range during the field sampling activities. In Step 1, the sample results were compared to the human health and ecological screening levels. As shown in **Table 9-1**, sample results exceeded the screening levels for at least one metal at all eight locations and five total metals.

On the basis of these exceedances, the decision analysis followed the path to Step 2.

9.4.2 Step 2

Because of the magnitude of the exceedances, more-realistic evaluations of the data were undertaken to decide if further action would be necessary. Potential ecological and human health risks were evaluated. The results of these evaluations are discussed as follows. COPCs were identified in the human health and ecological evaluations, so the decision analysis followed the path to Step 3.

HHRS Results

The risk-based screening evaluation for surface and subsurface soil at the Machine Gun Boresight Range (Fentress) is presented in **Tables 9-3 through 9-4b**.

Surface Soil

Tables 9-3 through 9-3b present the risk-based screening evaluation for surface soil. Four metals (antimony, arsenic, copper, and lead) were identified as Step 1 COPCs and were retained for evaluation in Step 2. Based on Step 2 (risk ratio using maximum detected concentrations), antimony and copper were carried forward to Step 3. Based on Step 3 (risk ratio using 95% UCLs), copper could not be eliminated and was retained as a COPC for surface soil. The potential risk associated with exposure to copper in surface soil is associated with one sample, OFMGBR-SS04-0610.

The average lead concentration in the surface soil is 4,272 mg/kg, which exceeds the lead screening level. Lead, along with copper, is considered a COPC for surface soil.

Subsurface Soil

Tables 9-4 through 9-4b present the risk-based screening evaluation for subsurface soil. Four metals (antimony, arsenic, copper, and lead) were identified as Step 1 COPCs and were retained for evaluation in Step 2. Based on Step 2 (risk ratio using maximum detected concentrations), antimony was carried forward to Step 3. Based on Step 3 (risk ratio using 95% UCLs), antimony was eliminated as a COPC for subsurface soil.

The average lead concentration in the subsurface soil is 2,223 mg/kg, which exceeds the lead screening level. Lead is considered a COPC for subsurface soil.

HHRS Results Summary

Based on the HHRS evaluation for the Machine Gun Boresight Range (Fentress), potential unacceptable risks were identified for both surface soil and subsurface soil. In order to assess the risk based on anticipated receptors (recreational users/visitors, trespassers, maintenance workers, and industrial workers), a more-quantitative risk assessment is needed.

Potential unacceptable risks for surface soil are associated with copper and lead, and for subsurface soil they are associated with lead.

Ecological Risk Screening Results

The results of the ecological risk evaluation for the Machine Gun Boresight Range (Fentress) are presented in **Tables 9-5 and 9-6**.

Surface Soil

Copper, lead, and zinc each exceeded ecological soil screening values for plants and soil invertebrates based on maximum detected concentrations (**Table 9-5**). Therefore, these three metals were identified as initial COPCs. HQs based on mean concentrations exceeded 1 for all three of these metals, substantially so for copper and lead. In particular, lead exceeded screening values in all eight surface soil samples by a factor of 2 or more, and copper exceeded screening values in seven of eight samples by a factor of 2 or more (**Table 9-6**). As a result, copper, lead, and zinc were identified as refined COPCs. However, the spatial extent of the potentially affected area is relatively small and is likely confined to the backstop area (about 25 feet by 100 feet).

Subsurface Soil

Copper, lead, and zinc each exceeded ecological soil screening values for plants and soil invertebrates based on maximum detected concentrations (**Table 9-5**), so they were identified as initial COPCs. HQs based on mean concentrations exceeded 1 for copper and lead. In particular, lead exceeded screening values in six of eight subsurface soil samples by a factor of 2 or more (**Table 9-6**). As a result, copper and lead were identified as COPCs. However, the spatial extent of the potentially affected area is relatively small and is likely confined to the backstop area.

Ecological Risk Screening Summary

Copper, lead, and zinc were identified as COPCs in surface soil, while copper and lead were also identified as COPCs in subsurface soil. Although the magnitude of the screening value exceedances was relatively high, particularly for lead, the spatial extent of the potentially affected area is relatively small and is likely confined to the backstop area. Therefore, potential unacceptable ecological risks are likely to be spatially limited.

9.4.3 Step 3

Antimony, copper, lead, and zinc were identified as COPCs in Step 2. In Step 3, the COPC results were compared to the established background values for eastern Virginia (presented in Section 3.7). All results exceeded background values, so a potential release is suspected.

9.5 Summary and Conclusions

Concentrations of some range-related MCs were found to exceed human and/or ecological screening values at all soil sampling locations. Based on the HHRS and ecological evaluations, potential unacceptable human health and ecological risks were identified for both surface soil and subsurface soil.

Although the magnitude of the screening value exceedances was relatively high, the spatial extent of the potentially affected area is relatively small and is likely confined to the backstop area. Therefore, potential unacceptable risks are likely to be spatially limited. Because of the relatively small area potentially affected, a soil removal action should be considered. A remedial investigation is recommended to further delineate the lateral and vertical extent of soil contamination and to establish site-specific background levels for the COPCs. In addition, quantitative HHRAs and ERAs should be conducted to assess risk based on anticipated receptors. In addition, the risk assessments can be used to calculate the risk-based cleanup goals based on anticipated land use. Following the completion of these tasks, the quantity of soils exceeding unacceptable risk/background levels can be determined.

Table 9-2
Soil Sample Analytical Results Machine Gun Boresight Range - NALF Fentress
NAS Oceana (CTO-WE03)
June 2010

Station ID	**CLEAN RSLs Residential Soil Adjusted 0510**	**ECO PAL**	OFMGBR-SO01	OFMGBR-SO02	OFMGBR-SO03	OFMGBR-SO04
Sample ID			OFMGBR-SS01-0610	OFMGBR-SS02-0610	OFMGBR-SS03-0610	OFMGBR-SS04-0610
Sample Date			06/18/10	06/18/10	06/18/10	06/18/10
Total Metals (MG/KG)						
Antimony	3.1	78	**8.92**	0.907 U	**0.4 J**	**22**
Arsenic	0.39	18	**4.15**	**2.32**	**1.69**	**4.59**
Copper	310	70	**727**	**206**	**168**	**68,400**
Lead	400	120	**5,530**	**406**	**242**	**17,100**
Nickel	150	38	**8.18**	**13.8**	**7.1**	**17.5**
Zinc	2,300	120	**93.7**	**46.3**	**24.4**	**6,290**

Station ID	**CLEAN RSLs Residential Soil Adjusted 0510**	**ECO PAL**	OFMGBR-SO01	OFMGBR-SO02	OFMGBR-SO03	OFMGBR-SO04
Sample ID			OFMGBR-SB01-0610	OFMGBR-SB02-0610	OFMGBR-SB03-0610	OFMGBR-SB04-0610
Sample Date			06/18/10	06/18/10	06/18/10	06/18/10
Total Metals (MG/KG)						
Antimony	3.1	78	**0.394 J**	**22.1**	0.902 U	**8.11**
Arsenic	0.39	18	**1.92**	**5.53**	**1.65**	**4.6**
Copper	310	70	**15**	**366**	**31.2**	**556**
Lead	400	120	**706**	**3,240**	**62.7**	**8,970**
Nickel	150	38	**9.11**	**7.65**	**5.84**	**7.77**
Zinc	2,300	120	**21.4**	**43.7**	**18.3**	**198**

Notes:

Exceeds RSL
Exceeds ECO

Bold indicates detections

J - Analyte present, value may or may not be accurate or precise

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

MG/KG - Milligrams per kilogram

Table 9-2
Soil Sample Analytical Results Machine Gun Boresight Range - NALF Fentress
NAS Oceana (CTO-WE03)
June 2010

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	OFMGBR-SO05	OFMGBR-SO06	OFMGBR-SO07	OFMGBR-SO08
Sample ID			OFMGBR-SS05-0610	OFMGBR-SS06-0610	OFMGBR-SS07-0610	OFMGBR-SS08-0610
Sample Date			06/18/10	06/18/10	06/18/10	06/18/10
Total Metals (MG/KG)						
Antimony	3.1	78	**1.78**	**3.4**	**1.06**	**3.51 L**
Arsenic	0.39	18	**1.82**	**2.62**	**1.57**	**2.68**
Copper	310	70	**191**	**457**	**72.8**	**338**
Lead	400	120	**1,280**	**4,790**	**775**	**4,050**
Nickel	150	38	**7.02**	**7.78**	**4.58**	**6.19**
Zinc	2,300	120	**47.2**	**93.3**	**17.5**	**80.2 L**

Station ID	CLEAN RSLs Residential Soil Adjusted 0510	ECO PAL	OFMGBR-SO05	OFMGBR-SO06	OFMGBR-SO07	OFMGBR-SO08
Sample ID			OFMGBR-SB05-0610	OFMGBR-SB06-0610	OFMGBR-SB07-0610	OFMGBR-SB08-0610
Sample Date			06/18/10	06/18/10	06/18/10	06/18/10
Total Metals (MG/KG)						
Antimony	3.1	78	**0.565 J**	**1.91**	0.791 U	**1.74**
Arsenic	0.39	18	**1.52**	**2.34**	**1.33**	**1.89**
Copper	310	70	**99.9**	**210**	**14.6**	**262**
Lead	400	120	**662**	**2,080**	**83.3**	**1,980**
Nickel	150	38	**6.45**	**11.4**	**6.71**	**8.68**
Zinc	2,300	120	**26.1**	**73.6**	**12.3**	**54.2**

Notes:

Exceeds RSL

Exceeds ECO

Bold indicates detections

J - Analyte present, value may or may not be accurate or precise

L - Analyte present, value may be biased low, actual value may be higher

U - The material was analyzed for, but not detected

MG/KG - Milligrams per kilogram

TABLE 9-3
Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Surface Soil
Machine Gun Boresight Range
NALF Fentress

Scenario Timeframe: Current/Future
Medium: Surface Soil
Exposure Medium: Surface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Surface Soil	**7440-36-0**	**Antimony**	**4.0E-01 J**	**2.2E+01**	**MG/KG**	**OFMGBR-SS04-0610**	**7/8**	**0.748 - 4.7**	**2.2E+01**	**N/A**	**3.1E+00 N**	**6.6E-01**	**SSL**	**YES**	**ASL**
	7440-38-2	**Arsenic**	**1.6E+00**	**4.6E+00**	**MG/KG**	**OFMGBR-SS04-0610**	**8/8**	**0.299 - 1.88**	**4.6E+00**	**N/A**	**3.9E-01 C***	**1.3E-03**	**SSL**	**YES**	**ASL**
	7440-50-8	**Copper**	**7.3E+01**	**6.8E+04**	**MG/KG**	**OFMGBR-SS04-0610**	**8/8**	**0.499 - 78.4**	**6.8E+04**	**N/A**	**3.1E+02 N**	**5.1E+01**	**SSL**	**YES**	**ASL**
	7439-92-1	**Lead**	**2.4E+02**	**1.7E+04**	**MG/KG**	**OFMGBR-SS04-0610**	**8/8**	**0.169 - 23.5**	**1.7E+04**	**N/A**	**4.0E+02 NL**	**N/A**		**YES**	**ASL**
	7440-02-0	Nickel	4.6E+00	1.8E+01	MG/KG	OFMGBR-SS04-0610	8/8	0.499 - 3.14	1.8E+01	N/A	1.5E+02 N	4.8E+01	SSL	NO	BSL
	7440-66-6	Zinc	1.8E+01	6.3E+03	MG/KG	OFMGBR-SS04-0610	8/8	0.997 - 31.4	6.3E+03	N/A	2.3E+03 N	6.8E+02	SSL	YES	ASL

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May , 2010. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. [Online]. Available: http://epa-prgs.ornl.gov/chemicals/index.shtml. Adjusted (noncarcinogenic RSLs adjusted by dividing by 10) residential soil RSLs.
The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.

[5] Rationale Codes
Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
SSL = Protection of groundwater risk-based SSL from RSL Table
C* = N screening level < 100x C screening level, therefore N screening value/10 used as screening level
N = Noncarcinogenic
N/A = Not available
NL = Noncarcinongenic lead residential soil RSL not adjusted by dividing by 10.
J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.

TABLE 9-3a
Risk Ratio Screening for Surface Soil, Maximum Detected Concentration in Surface Soil
Machine Gun Boresight Range
NALF Fentress

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample Location of Maximum Detected Concentration	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)								
Antimony	**7 / 8**	**2.2E+01**	**OFMGBR-SS04-0610**	**3.1E+01**	**1**	**0.7**	**NA**	**Longevity, Blood**
Arsenic	8 / 8	4.6E+00	OFMGBR-SS04-0610	3.9E-01	1E-06	NA	1E-05	NA
Copper	**8 / 8**	**6.8E+04**	**OFMGBR-SS04-0610**	**3.1E+03**	**1**	**22**	**NA**	**Gastrointestinal**
Cumulative Corresponding Hazard Index[c]						**23**		
Cumulative Corresponding Cancer Risk[d]							**1E-05**	
							Total Longevity HI =	0.7
							Total Blood HI =	0.7
							Total Gastrointestinal HI =	22.1

Notes:

a Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

b Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

c Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

d Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Chemical of Potential Concern

mg/kg = micrograms per kilogram

NA = Not available/not applicable.

TABLE 9-3b

Risk Ratio Screening for Surface Soil, 95% UCL Concentration in Surface Soil

Machine Gun Boresight Range

NALF Fentress

Analyte	Detection Frequency	95% UCL		95% UCL Rationale	Screening Level	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)									
Antimony	7 / 8	1.7E+01	95% KM	1, 3	3.1E+01	1.E+00	0.5	NA	Longevity, Blood
Copper	**8 / 8**	**6.8E+04**	**Max**	**4, 5**	**3.1E+03**	**1.E+00**	**22**	**NA**	**Gastrointestinal**
Cumulative Corresponding Hazard Index[c]							**23**		
Cumulative Corresponding Cancer Risk[d]								**NA**	

Total Longevity HI =	0.5
Total Blood HI =	0.5
Total Gastrointestinal HI =	1

[a] Corresponding Hazard Index equals 95% UCL divided by the RSL divided by the acceptable risk level.

[b] Corresponding Cancer Risk equals 95% UCL divided by the RSL divided by the acceptable risk level.

[c] Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

[u] Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05,

Constituents selected as COPCs are indicated by shading.

mg/kg = milligrams per kilogram

HI = Hazard Index

ProUCL, Version 4.00.05 used to determine distribution of data and calculate 95% UCL, following recommendations in users guide (USEPA. May 2010. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).

Options: 95% Kaplan-Meier Chebyshev UCL (95% KM); Maximum detected concentration (Max)

UCL Rationale:

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.

(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.

(3) Test indicates data are gamma distributed.

(4) Distribution tests are inconclusive

(5) Maximum value used because calculated 95% UCL exceeds maximum concentration.

TABLE 9-4

Occurrence, Distribution, and Selection of Chemicals of Potential Concern in Subsurface Soil

Machine Gun Boresight Range

NALF Fentress

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Subsurface Soil	**7440-36-0**	**Antimony**	**3.9E-01 J**	**2.2E+01**	**MG/KG**	**OFMGBR-SB02-0610**	**6/8**	**0.791 - 4.77**	**2.2E+01**	**N/A**	**3.1E+00 N**	**6.6E-01**	**SSL**	**YES**	**ASL**
	7440-38-2	**Arsenic**	**1.3E+00**	**5.5E+00**	**MG/KG**	**OFMGBR-SB02-0610**	**8/8**	**0.317 - 0.41**	**5.5E+00**	**N/A**	**3.9E-01 C***	**1.3E-03**	**SSL**	**YES**	**ASL**
	7440-50-8	**Copper**	**1.5E+01**	**5.6E+02**	**MG/KG**	**OFMGBR-SB04-0610**	**8/8**	**0.528 - 0.683**	**5.6E+02**	**N/A**	**3.1E+02 N**	**5.1E+01**	**SSL**	**YES**	**ASL**
	7439-92-1	**Lead**	**6.3E+01**	**9.0E+03**	**MG/KG**	**OFMGBR-SB04-0610**	**8/8**	**0.158 - 4.81**	**9.0E+03**	**N/A**	**4.0E+02 NL**	**N/A**		**YES**	**ASL**
	7440-02-0	Nickel	5.8E+00	1.1E+01	MG/KG	OFMGBR-SB06-0610	8/8	0.528 - 0.683	1.1E+01	N/A	1.5E+02 N	4.8E+01	SSL	NO	BSL
	7440-66-6	Zinc	1.2E+01	2.0E+02	MG/KG	OFMGBR-SB04-0610	8/8	1.06 - 1.37	2.0E+02	N/A	2.3E+03 N	6.8E+02	SSL	NO	BSL

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Oak Ridge National Laboratory (ORNL). May , 2010. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. [Online]. Available: http://epa-prgs.ornl.gov/chemicals/index.shtml. Adjusted (noncarcinogenic RSLs adjusted by dividing by 10) residential soil RSLs. The soil value of 400 mg/kg for lead is from the Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, USEPA, July 14, 1994.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

SSL = Protection of groundwater risk-based SSL from RSL Table

C* = N screening level < 100x C screening level, therefore N screening value/10 used as screening level

N = Noncarcinogenic

N/A = Not available

NL = Noncarcinongenic lead residential soil RSL not adjusted by dividing by 10.

J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.

TABLE 9-4a
Risk Ratio Screening for Subsurface Soil, Maximum Detected Concentration in Subsurface Soil
Machine Gun Boresight Range
NALF Fentress

Analyte	Detection Frequency	Maximum Detected Concentration (Qualifier)	Sample Location of Maximum Detected Concentration	Residential Soil RSL	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)								
Antimony	**6 / 8**	**2.2E+01**	**OFMGBR-SB02-0610**	**3.1E+01**	**1**	**0.7**	**NA**	**Longevity, Blood**
Arsenic	8 / 8	5.5E+00	OFMGBR-SB02-0610	3.9E-01	1E-06	NA	1E-05	NA
Copper	8 / 8	5.6E+02	OFMGBR-SB04-0610	3.1E+03	1	0.2	NA	Gastrointestinal
Cumulative Corresponding Hazard Index[c]						**0.9**		
Cumulative Corresponding Cancer Risk[d]							**1E-05**	

Total Longevity HI =	0.7
Total Blood HI =	0.7
Total Gastrointestinal HI =	0.2

Notes:

a Corresponding Hazard Index equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

b Corresponding Cancer Risk equals maximum detected concentration divided by the RSL divided by the acceptable risk level.

c Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

d Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Constituents selected as COPCs are indicated by shading.

COPC = Chemical of Potential Concern

mg/kg = micrograms per kilogram

NA = Not available/not applicable.

TABLE 9-4b

Risk Ratio Screening for Subsurface Soil, 95% UCL Concentration in Subsurface Soil

Machine Gun Boresight Range

NALF Fentress

Analyte	Detection Frequency	95% UCL		95% UCL Rationale	Screening Level	Acceptable Risk Level	Corresponding Hazard Index[a]	Corresponding Cancer Risk[b]	Target Organ
Metals (mg/kg)									
Antimony	6 / 8	1.6E+01	95% KM	1, 3	3.1E+01	1.E+00	0.5	NA	Longevity, Blood
Cumulative Corresponding Hazard Index[c]							**0.5**		
Cumulative Corresponding Cancer Risk[d]								**NA**	

Total Longevity HI =	0.5
Total Blood HI =	0.5

[a] Corresponding Hazard Index equals 95% UCL divided by the RSL divided by the acceptable risk level.

[b] Corresponding Cancer Risk equals 95% UCL divided by the RSL divided by the acceptable risk level.

[c] Cumulative Corresponding Hazard Index equals sum of Corresponding Hazard Indices for each constituent.

[d] Cumulative Corresponding Cancer Risk equals sum of Corresponding Cancer Risks for each constituent.

Constituent selected as COPC if it contributes to an overall Hazard Index by target organ greater than 0.5 or Cumulative Corresponding Cancer Risk greater than 5E-05,

Constituents selected as COPCs are indicated by shading.

mg/kg = milligrams per kilogram

HI = Hazard Index

ProUCL, Version 4.00.05 used to determine distribution of data and calculate 95% UCL, following recommendations

in users guide (USEPA. May 2010. ProUCL, Version 4.0. Prepared by Lockheed Martin Environmental Services).

Options: 95% Kaplan-Meier Chebyshev UCL (95% KM)

UCL Rationale:

(1) Shapiro-Wilk W Test/Lilliefors test indicates data are log-normally distributed.

(2) Shapiro-Wilk W Test/Lilliefors indicates data are normally distributed.

(3) Test indicates data are gamma distributed.

(4) Distribution tests are inconclusive

(5) Maximum value used because calculated 95% UCL exceeds maximum concentration.

Table 9-5

Ecological Screening Statistics - Machine Gun Boresight Range (Fentress) - Plants and Soil Invertebrates

Naval Auxiliary Landing Field Fentress

Chemical	Range of Non-Detect Values	Frequency of Detection	Minimum Concentration Detected	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Arithmetic Mean	Standard Deviation of Mean	95% UCL (Norm)	Screening Value	Frequency of Exceedance[1]	Maximum Hazard Quotient	Initial COPC?	95% UCL Hazard Quotient	Mean Hazard Quotient	Refined COPC?
Surface Soil															
Inorganics (MG/KG)															
Antimony	0.91 - 0.91	7 / 8	0.40	22.0	OFMGBR-SS04-0610	5.19	7.33	10.1	78.0	0 / 8	0.28	NO	--	--	NO
Arsenic	-- - --	8 / 8	1.57	4.59	OFMGBR-SS04-0610	2.68	1.13	3.44	18.0	0 / 8	0.26	NO	--	--	NO
Copper	-- - --	8 / 8	72.8	68,400	OFMGBR-SS04-0610	8,820	24,075	24,946	70.0	8 / 8	977	**YES**	356	126	**YES**
Lead	-- - --	8 / 8	242	17,100	OFMGBR-SS04-0610	4,272	5,591	8,017	120	8 / 8	143	**YES**	66.8	35.6	**YES**
Nickel	-- - --	8 / 8	4.58	17.5	OFMGBR-SS04-0610	9.02	4.35	11.9	38.0	0 / 8	0.46	NO	--	--	NO
Zinc	-- - --	8 / 8	17.5	6,290	OFMGBR-SS04-0610	837	2,204	2,313	120	1 / 8	52.4	**YES**	19.3	6.97	**YES**
Subsurface Soil															
Inorganics (MG/KG)															
Antimony	0.79 - 0.90	6 / 8	0.39	22.1	OFMGBR-SB02-0610	4.46	7.58	9.54	78.0	0 / 8	0.28	NO	--	--	NO
Arsenic	-- - --	8 / 8	1.33	5.53	OFMGBR-SB02-0610	2.60	1.57	3.65	18.0	0 / 8	0.31	NO	--	--	NO
Copper	-- - --	8 / 8	14.6	556	OFMGBR-SB04-0610	194	195	325	70.0	5 / 8	7.94	**YES**	4.64	2.78	**YES**
Lead	-- - --	8 / 8	62.7	8,970	OFMGBR-SB04-0610	2,223	2,943	4,194	120	6 / 8	74.8	**YES**	35.0	18.5	**YES**
Nickel	-- - --	8 / 8	5.84	11.4	OFMGBR-SB06-0610	7.95	1.78	9.14	38.0	0 / 8	0.30	NO	--	--	NO
Zinc	-- - --	8 / 8	12.3	198	OFMGBR-SB04-0610	56.0	61.0	96.8	120	1 / 8	1.65	**YES**	0.81	0.47	NO

1 - Count of detected samples exceeding or equaling Screening Value

Table 9-6
Exceedances - Machine Gun Boresight Range (Fentress) Surface and Subsurface Soil - Plants and Soil Invertebrates
Naval Auxiliary Landing Field Fentress

Chemical	Ecological Soil Screening Value	OFMGBR-SO01	OFMGBR-SO02	OFMGBR-SO03	OFMGBR-SO04	OFMGBR-SO05
		OFMGBR-SS01-0610	OFMGBR-SS02-0610	OFMGBR-SS03-0610	OFMGBR-SS04-0610	OFMGBR-SS05-0610
		06/18/10	06/18/10	06/18/10	06/18/10	06/18/10
Inorganics (MG/KG)						
Antimony	78.0	8.92	0.907 U	0.400 J	22.0	1.78
Arsenic	18.0	4.15	2.32	1.69	4.59	1.82
Copper	70.0	727	206	168	68,400	191
Lead	120	5,530	406	242	17,100	1,280
Nickel	38.0	8.18	13.8	7.10	17.5	7.02
Zinc	120	93.7	46.3	24.4	6,290	47.2

Chemical	Ecological Soil Screening Value	OFMGBR-SO01	OFMGBR-SO02	OFMGBR-SO03	OFMGBR-SO04	OFMGBR-SO05
		OFMGBR-SB01-0610	OFMGBR-SB02-0610	OFMGBR-SB03-0610	OFMGBR-SB04-0610	OFMGBR-SB05-0610
		06/18/10	06/18/10	06/18/10	06/18/10	06/18/10
Inorganics (MG/KG)						
Antimony	78.0	0.394 J	22.1	0.902 U	8.11	0.565 J
Arsenic	18.0	1.92	5.53	1.65	4.60	1.52
Copper	70.0	15.0	366	31.2	556	99.9
Lead	120	706	3,240	62.7	8,970	662
Nickel	38.0	9.11	7.65	5.84	7.77	6.45
Zinc	120	21.4	43.7	18.3	198	26.1

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections

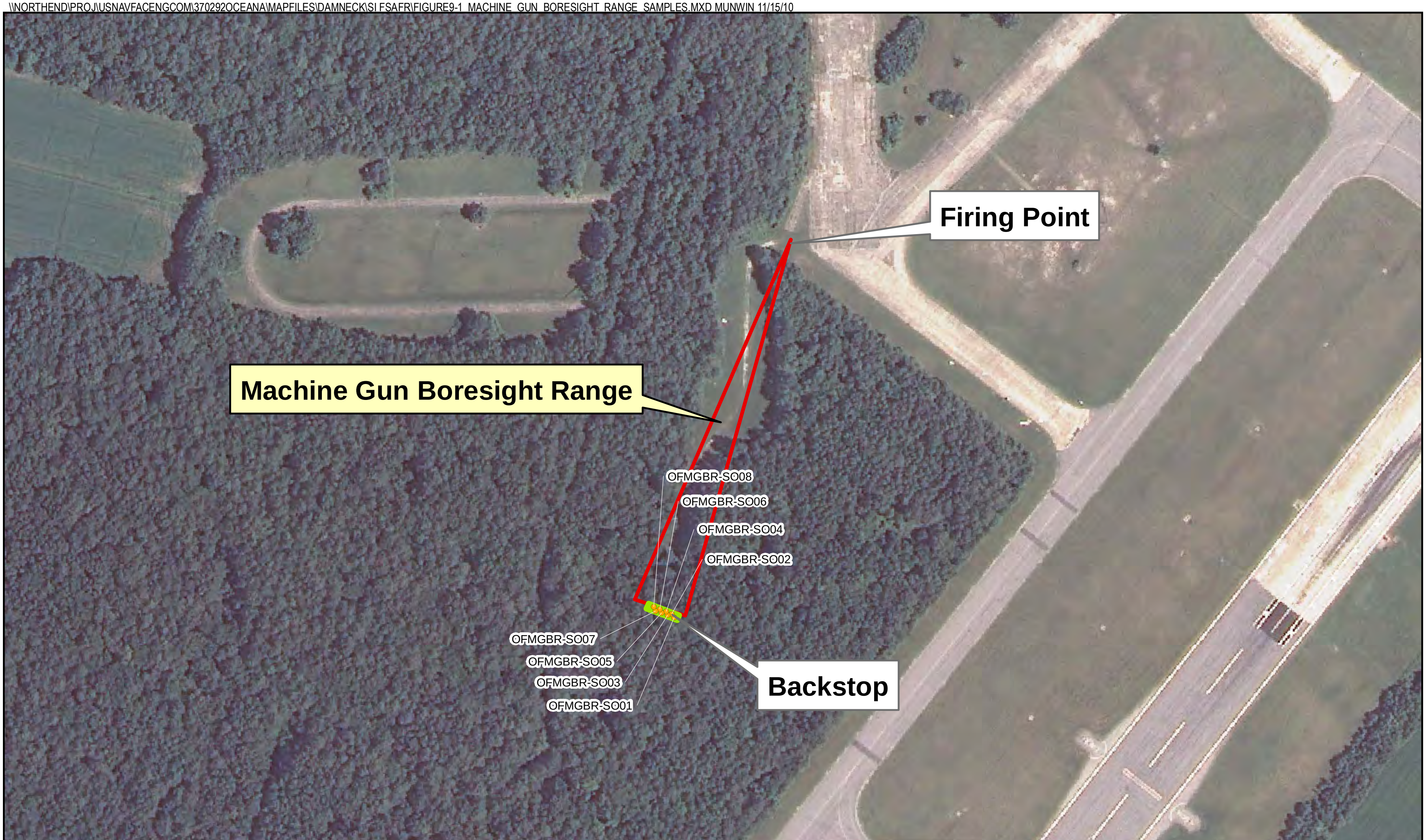
Table 9-6
Exceedances - Machine Gun Boresight Range (Fentress) Surface and Subsurface Soil - Plants and Soil Invertebrates
Naval Auxiliary Landing Field Fentress

Chemical	Ecological Soil Screening Value	OFMGBR-SO06	OFMGBR-SO07	OFMGBR-SO08
		OFMGBR-SS06-0610	OFMGBR-SS07-0610	OFMGBR-SS08-0610
		06/18/10	06/18/10	06/18/10
Inorganics (MG/KG)				
Antimony	78.0	3.40	1.06	3.51 L
Arsenic	18.0	2.62	1.57	2.68
Copper	70.0	457	72.8	338
Lead	120	4,790	775	4,050
Nickel	38.0	7.78	4.58	6.19
Zinc	120	93.3	17.5	80.2 L

Chemical	Ecological Soil Screening Value	OFMGBR-SO06	OFMGBR-SO07	OFMGBR-SO08
		OFMGBR-SB06-0610	OFMGBR-SB07-0610	OFMGBR-SB08-0610
		06/18/10	06/18/10	06/18/10
Inorganics (MG/KG)				
Antimony	78.0	1.91	0.791 U	1.74
Arsenic	18.0	2.34	1.33	1.89
Copper	70.0	210	14.6	262
Lead	120	2,080	83.3	1,980
Nickel	38.0	11.4	6.71	8.68
Zinc	120	73.6	12.3	54.2

Notes:
Grey highlighting indicates value greater than screening value
Bold indicates detections

\\NORTHEND\PROJ\USNAVFACENGCOM\370292OCEANA\MAPFILES\DAMNECK\SI FSAFR\FIGURE9-1_MACHINE_GUN_BORESIGHT_RANGE_SAMPLES.MXD MUNWIN 11/15/10



Legend

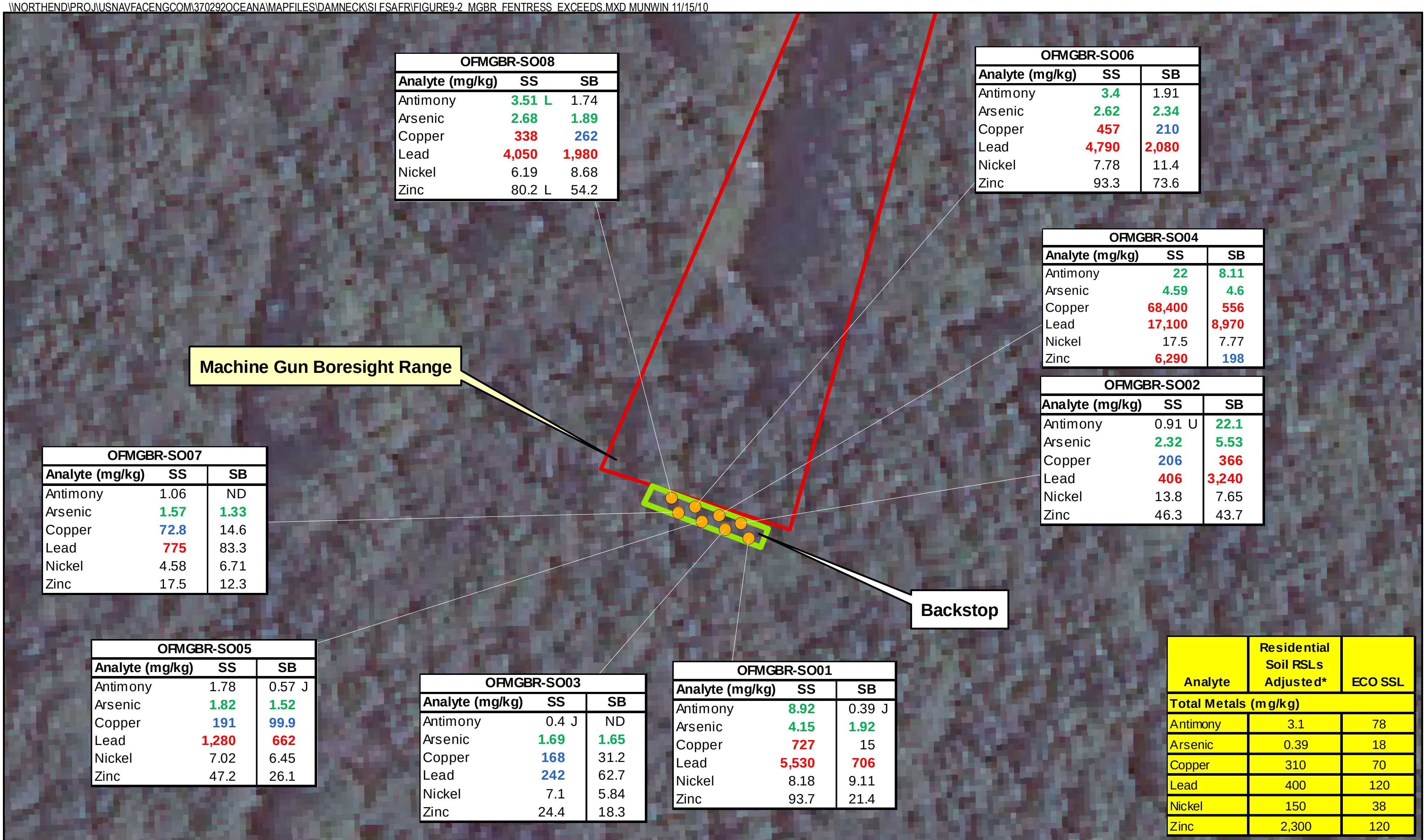
- Soil Sample Location
- MRP Site
- Backstop

N W E S

0 150 300 Feet

Figure 9-1
Machine Gun Boresight Range Sample Locations,
NALF Fentress
Site Inspection of the Former
Small Arms Firing Ranges
NALF Fentress, NAS Oceana
Virginia Beach, Virginia

CH2MHILL



OFMGBR-SO08		
Analyte (mg/kg)	SS	SB
Antimony	3.51 L	1.74
Arsenic	2.68	1.89
Copper	338	262
Lead	4,050	1,980
Nickel	6.19	8.68
Zinc	80.2 L	54.2

OFMGBR-SO06		
Analyte (mg/kg)	SS	SB
Antimony	3.4	1.91
Arsenic	2.62	2.34
Copper	457	210
Lead	4,790	2,080
Nickel	7.78	11.4
Zinc	93.3	73.6

OFMGBR-SO04		
Analyte (mg/kg)	SS	SB
Antimony	22	8.11
Arsenic	4.59	4.6
Copper	68,400	556
Lead	17,100	8,970
Nickel	17.5	7.77
Zinc	6,290	198

OFMGBR-SO02		
Analyte (mg/kg)	SS	SB
Antimony	0.91 U	22.1
Arsenic	2.32	5.53
Copper	206	366
Lead	406	3,240
Nickel	13.8	7.65
Zinc	46.3	43.7

OFMGBR-SO07		
Analyte (mg/kg)	SS	SB
Antimony	1.06	ND
Arsenic	1.57	1.33
Copper	72.8	14.6
Lead	775	83.3
Nickel	4.58	6.71
Zinc	17.5	12.3

OFMGBR-SO05		
Analyte (mg/kg)	SS	SB
Antimony	1.78	0.57 J
Arsenic	1.82	1.52
Copper	191	99.9
Lead	1,280	662
Nickel	7.02	6.45
Zinc	47.2	26.1

OFMGBR-SO03		
Analyte (mg/kg)	SS	SB
Antimony	0.4 J	ND
Arsenic	1.69	1.65
Copper	168	31.2
Lead	242	62.7
Nickel	7.1	5.84
Zinc	24.4	18.3

OFMGBR-SO01		
Analyte (mg/kg)	SS	SB
Antimony	8.92	0.39 J
Arsenic	4.15	1.92
Copper	727	15
Lead	5,530	706
Nickel	8.18	9.11
Zinc	93.7	21.4

Analyte	Residential Soil RSLs Adjusted*	ECO SSL
Total Metals (mg/kg)		
Antimony	3.1	78
Arsenic	0.39	18
Copper	310	70
Lead	400	120
Nickel	150	38
Zinc	2,300	120

Legend
- Soil Sample Location
- MRP Site
- Backstop

NOTES:
Concentrations shown in green exceed the USEPA residential soil regional screening levels
Concentrations shown in blue exceed the ecological soil screening levels
Concentrations shown in red exceed both the ecological and residential screening levels
L - Analyte present, value may be biased low, actual value may be higher
R - Unreliable Result
ND - Analyte not detected
mg/kg - milligrams per kilogram
SS - Surface soil
SB - Subsurface soil

N
W E
S

0 40 80
Feet

Figure 9-2
Machine Gun Boresight Range Exceedances,
NALF Fentress
Site Inspection of the Former
Small Arms Firing Ranges
NALF Fentress, NAS Oceana
Virginia Beach, Virginia

CH2MHILL

SECTION 10
Summary and Conclusions

Field investigations were conducted at the six former small arms firing ranges at NAS Oceana in accordance with the UFP-SAP (CH2M HILL, 2010) between June 14 and 18, 2010, and May 9 through 11, 2011.

A visual survey of each location, aided by a handheld all-metals detector (when sites had accessible areas that could be traversed without damaging or removing vegetation), was conducted to identify surface areas containing metallic debris suspected to be associated with the use of small arms ammunition. Discrete soil samples were collected from 120 locations and sent to the laboratory for analysis.

The validated results were evaluated using the decision points and actions summarized on **Figure 3-1** to determine if a release posing potential risk has occurred at the six sites and if further action or expanded investigation is warranted.

Based on the conservative risk screening process, the Pistol Range North, Pistol Range South, and the Rifle Range sites do not pose unacceptable risks to human health or the environment. Therefore, no further investigation or action is recommended for these sites.

The Machine Gun Boresight Range (Oceana), Machine Gun Boresight Range (Fentress), and the Skeet and Trap Range were found to potentially pose unacceptable risks to human health and the environment. Therefore, potential releases are suspected and further investigation or action is recommended for these sites.

At the Machine Gun Boresight Range (Oceana) and Machine Gun Boresight Range (Fentress), concentrations of range-related MC were found to exceed human and/or ecological screening values at all soil sampling locations. Based on the HHRS and ERA evaluations, potential unacceptable human health and ecological risks were identified for both surface soil and subsurface soil. Antimony, copper, lead, and zinc were identified as COPCs. Copper and lead were identified as COPCs in surface soil, and antimony and lead were identified as COPCs in subsurface soil during the HHRS. Copper, lead, and zinc were identified as COPCs in surface soil, while copper and lead were also identified as COPCs in subsurface soil during the ERA.

Although the magnitude of the screening value exceedances at the Machine Gun Boresight Range (Oceana) and Machine Gun Boresight Range (Fentress) sites were relatively high, the spatial extent of the potentially affected areas is relatively small and is likely confined to the backstop areas. As a result, potential unacceptable risks are likely to be spatially limited. Because of the relatively small areas potentially affected, a soil removal action should be considered at each site. Remedial investigations are recommended to further delineate the lateral and vertical extent of soil contamination and to establish site-specific background levels for the COPCs. In addition, quantitative HHRAs and ERAs should be conducted to assess risk based on anticipated receptors. The risk assessments also can be used to calculate the risk-based cleanup goals based on anticipated land use. Following the completion of these tasks, the quantity of soils exceeding unacceptable risk/background levels can be determined.

Based on the HHRS and ERA evaluations for the Skeet and Trap Range, unacceptable human health risks were identified for surface soil, and unacceptable ecological risks were identified for surface soil and sediment. PAHs and lead were identified as COPCs in surface soil during the HHRS. The ERS identified lead and PAHs as COPCs in surface soil and lead as a COPC in lake sediments.

A remedial investigation is recommended to further delineate the lateral and vertical extent of PAH and lead contamination in the soils and to establish site-specific background levels for lead. In addition, quantitative HHRAs and ERAs should be conducted to assess risk based on anticipated receptors.

Although lead exceeded human health screening criteria at one sediment sampling location, the average concentration of 76 mg/kg was less than the screening level, and there were no unacceptable human health risks identified. Only minimal unacceptable ecological risks were identified due to exposure to lead in sediment, in a spatially limited area. Further investigation of sediment is recommended to evaluate these limited potential risks.

SECTION 11
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Appendix A
Field Notebook and Chain-of-Custody Records

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

14292

Send Results to:
Name Vickie Webber
Company CH2M HILL
Address 5700 Cleveland St, Ste 101
City Virginia Beach
State, Zip VA, 23462
Phone 757-671-6252
Fax
E-mail

Send Invoice to:
Name same
Company
Address
City
State, Zip
Phone
Fax
E-mail

Project No./Name:

Sampler's (Signature):

Analysis Requirements: Lead, 6010B; TOC, Lloyd Kahn; PAH, 8270C

Lab Use Only:

	Y	N	NA
VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #: 4349
CAR #: —

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	Lead, 6010B	TOC, Lloyd Kahn	PAH, 8270C	Comments	No. of Bottles	Lab Use Only Containers/Pres.
1105097-01	5/9/11 1400	DNSTR-SD01-0511	SD	X	X	X		1	1M
-02	5/9/11 1405	DNSTR-SD01P-0511	↓	X	X	X		1	↓
-03	5/9/11 1415	DNSTR-SD02-0511	↓	X	X	X	MS/MSD	3	3M
-04	5/9/11 1630	DNSTR-EB050911	Blank	X		X		3	1CN1+2H
-05	5/10/11 1035	DNSTR-SD03-0511	SD	X	X			1	1M
-06	5/10/11 1040	DNSTR-SD07-0511	↓	X	X			1	↓
-07	5/10/11 1050	DNSTR-SD11-0511	↓	X				1	↓
-08	5/10/11 1100	DNSTR-SD12-0511	↓	X				1	↓
-09	5/10/11 1105	DNSTR-SD08-0511	↓	X	X			1	↓
-10	5/10/11 1110	DNSTR-SD04-0511	↓	X	X			1	↓
-11	5/10/11 1120	DNSTR-SD05-0511	↓	X				1	↓
-12	5/10/11 1125	DNSTR-SD09-0511	↓	X	X			1	↓

	Date/Time	
Sample Kit Prep'd by: (Signature)		Received By: (Signature)
Relinquished by: (Signature) [signature]	5/10/11 1630	Received By: (Signature)
Relinquished by: (Signature)		Received By: (Signature)
Received for Laboratory by: (Signature) [signature]	5-11-11 09:00	Temperature 2.0°C

REMARKS:

Details:
Page 1 of 3
Cooler No. 1 of 1
Date Shipped 5/10/11
Shipped By
Turnaround

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

14294

Send Results to:	Send Invoice to:	Lab Use Only:
Name Vickie Weber	Name Same	VOA Headspace Y N NA (NA circled)
Company CH2M Hill	Company	Field Filtered Y N NA (N circled)
Address 5700 Cleveland St	Address	Correct Containers Y N NA (Y circled)
City Virginia Beach	City	Discrepancies Y N NA (N circled)
State, Zip VA, 23462	State, Zip	Cust. Seals Intact Y N NA (Y circled)
Phone 757-671-6252	Phone	Containers Intact Y N NA (Y circled)
Fax	Fax	Airbill #: 4349
E-mail	E-mail	CAR #: —
Project No./Name:	Sampler's (Signature):	

Analysis Requirements: Lead, 6010B; TOC, Lloyd Kahn; ~~PAH, 8270C~~

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	Lead, 6010B	TOC, Lloyd Kahn	~~PAH, 8270C~~	Comments	No. of Bottles	Lab Use Only Containers/Pres.
1105097-13	5/10/11 1130	DNSTR-SD13-0511	SD	X	X			1	1M
-14	1140	DNSTR-SD16-0511		X	X			1	
-15	1145	DNSTR-SD17-0511		X				1	
-16	1148	DNSTR-SD17R-0511		X				1	
-17	1150	DNSTR-SD14-0511		X	X			1	
-18	1245	DNSTR-SD20-0511		X	X			1	
-19	1250	DNSTR-SD19-0511		X	X			1	
-20	1255	DNSTR-SD15-0511		X	X			1	
-21	1310	DNSTR-SD18-0511		X	X			1	
-22	1315	DNSTR-SD10-0511		X	X			1	
-23	1320	DNSTR-SD06-0511		X				1	
-24	1455	DNSTR-EB051011	Blank	X				3	1M + 2H

Sample Kit Prep'd by: (Signature)	Date/Time	Received By: (Signature)
Relinquished by: (Signature) [signature]	Date/Time 5/10/11 1630	Received By: (Signature)
Relinquished by: (Signature)	Date/Time	Received By: (Signature)
Received for Laboratory by: (Signature) [signature]	Date/Time 5-11-11 09:00	Temperature ° 2.0 C

REMARKS:
2 ambers included for sample DNSTR-EB051011 should NOT be analyzed! Mistakenly packed in cooler!

Details:
Page 2 of 3
Cooler No. 1 of 1
Date Shipped 5/10/11
Shipped By [signature]
Turnaround

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

14293

Send Results to:	Send Invoice to:	Lab Use Only:
Name Vickie Weber	Name same	VOA Headspace Y N NA (NA circled)
Company CH2M HILL	Company	Field Filtered Y N NA (N circled)
Address 5700 Cleveland St	Address	Correct Containers Y N NA (Y circled)
City Virginia Beach	City	Discrepancies Y N NA (N circled)
State, Zip VA, 23462	State, Zip	Cust. Seals Intact Y N NA (Y circled)
Phone 757-671-6252	Phone	Containers Intact Y N NA (Y circled)
Fax	Fax	Airbill #: 4349
E-mail	E-mail	CAR #: —
Project No./Name:	Sampler's (Signature):	

Analysis Requirements: Lead, 6010B; PAH, 8270C

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	Lead, 6010B	PAH, 8270C	Comments	No. of Bottles	Lab Use Only Containers/Pres.
1105057-25	5/10/11 1500	DNSTR-FB051011	Blank	X	X	SD Blank	3	1CN/+2H

Signature	Date/Time	Received By: (Signature)
Sample Kit Prep'd by: (Signature)	Date/Time	Received By: (Signature)
Relinquished by: (Signature)	Date/Time	Received By: (Signature)
Relinquished by: (Signature)	Date/Time	Received By: (Signature)
Received for Laboratory by: (Signature) [signature]	Date/Time 5-11-11 09:00	Temperature 2.0 °C

REMARKS:

Details:
Page 3 of 3
Cooler No. 1 of 1
Date Shipped 5/10/11
Shipped By
Turnaround

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

14290

Send Results to:
Name Vickie Weber
Company CH2M HILL
Address 5700 Cleveland St
City Virginia Beach
State, Zip VA, 23462
Phone 757-671-6252
Fax
E-mail victoria.weber@ch2m.com

Project No./Name:

Send Invoice to:
Name See SOW/Same
Company
Address
City
State, Zip
Phone
Fax
E-mail

Sampler's (Signature):

Analysis Requirements: ~~Lead, 6010B~~ ; PAH, 8270C

Lab Use Only:
VOA Headspace Y N NA (NA circled)
Field Filtered Y N NA (N circled)
Correct Containers Y N NA (Y circled)
Discrepancies Y N NA (N circled)
Cust. Seals Intact Y N NA (Y circled)
Containers Intact Y N NA (Y circled)
Airbill #: 9801
CAR #: —

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	~~Lead, 6010B~~	PAH, 8270C	Comments	No. of Bottles	Lab Use Only Containers/Pres.
1105116-01	5/11/11 1405	DNSTR-SS22-0511			X			1m
-02	1410	DNSTR-SS23-0511			X			↓
-03	1420	DNSTR-SS24-0511			X			↓
-04	1430	DNSTR-SS25-0511			X			↓
gm		~~DNSTR-SS26-0511~~						
-05	5/11/11 1305	DNSTR-EB051111			X			2H

	Date/Time	Received By: (Signature)
Sample Kit Prep'd by: (Signature)		
Relinquished by: (Signature) [signature]	5/11/11 1630	
Relinquished by: (Signature)		
Received for Laboratory by: (Signature) [signature]	5-12-11 09:00	Temperature 2.8°C

REMARKS:
Samples to be analyzed for PAHs ONLY! No lead analysis

Details:
Page 1 of 1
Cooler No. 1 of 1
Date Shipped 5/11/11
Shipped By
Turnaround

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

Location NAS Oceana Date 5/3/11

Project / Client salvage yard property line soil sampling

1515 OSAL-LP18-0511 sampled for lead at ~1' depth between stakes 8003 and 8002, ~~1-40ml~~ 1-4oz glass jar

1520 OSAL-LP19-0511 sampled for lead at ~1' depth @ stake 8002 ~20' south of 8002 due to thick brush, 1-4oz glass jar

1530 K. Coke & M. Ost offsite for XBO office to ship cooler
- sign over book to M. Ost

Kimberly Coke 5/3/11

M. L. Ost

Location Dam neck Date 5/9/11

Project / Client Lake Tecumseh sediment sampling

1020	~~am~~ M. Ost & G. Moore arrive at pass office to obtain vehicle pass for cargo van
1035	arrive onsite
1040	unload boat & other supplies from van
1045	H&S Brief: take freq. breaks/heat, sunscreen, & boat safety
1050	begin unpaking equipment
1100	M. Ost testing GPS
1147	GPS will not function Go Back to office To fix GPS
1330	arrive back onsite w/ working GPS, unload
1350	~~[illegible]~~ mob (gm) out in waders to SD01
1400	collect DNSTR-SD01-0511 for metals & PAH; visual inspection: No pellets; all clay, unable to sieve
1405	collect DNSTR-SD01P-0511 for metals & PAH
1410	mob to DNSTR-SD02

Location Dam neck Date 5/9/11

Project / Client lake Tecumseh sediment sampling

1415 collect $\boxed{\text{DNSTR-SD02-0511}}$ for metals & PAH, visual inspection of sample indicates no pellets. all clay, unable to sieve

Collect $\boxed{\text{DNSTR-SD02-0511-MS}}$

$\boxed{\text{DNSTR-SD02-0511-SD}}$

1450 call Vicki Webber - table in proj. instructions indicates TOC should be collected. but lab packing sheets do not indicate TOC - should it be collected & if so, do we need an extra jar? Vickie to call us back

1507 Boat Has No Plug Stop Sampling To go find Plug.

1530 buy plug at West marine

1630 arrive at Office -

1630 Collect $\boxed{\text{DNSTR-EB050911}}$ for PAH Pb

1645 put samples in mud room Fridge

1650 Offsite

Location Dam neck Date 5/10/11

Project / Client lake Tecumseh sed. Sampling

700 am MOST & GMoore meet at office

705 depart office

0820 arrive onsite after heavy traffic M.OST begins setting up GPS

0830 H&S frequent breaks / Long day, ticks, Boat safety

0835 Begin to load boat w/ equipment

0840 call C Bowman about GPS - having same issues as yesterday - left a message

0900 mob back to office for new GPS

0930 arrive at office - M.OST out w/ C Bowman to fix GPS -

0940 moB Back to Site

1015 arrive on site

1030 put boat in water

1035 collect $\boxed{\text{DNSTR-SD03-0511}}$

1040 collect $\boxed{\text{DNSTR-SD07-0511}}$

1050 Collect $\boxed{\text{DNSTR-SD11-0511}}$

1100 Collect $\boxed{\text{DNSTR-SD12-0511}}$

1105 Collect $\boxed{\text{DNSTR-SD08-0511}}$

1110 collect $\boxed{\text{DNSTR-SD04-0511}}$

1120 Collect $\boxed{\text{DNSTR-SD05-0511}}$

Location Dam neck Date 5/10/11

Project / Client lake Tecumseh Sed. Samp.

1125 collect DNSTR-SD09-0511
1130 collect DNSTR-SD13-0511
1140 collect DNSTR-SD16-0511
1145 collect DNSTR-SD17-0511
1150 collect DNSTR-SD14-0511
1200 mob to shore for lunch & more ziploc baggies
1230 back out on water
1245 collect DNSTR-SD20-0511
1250 collect DNSTR-SD19-0511
1255 collect DNSTR-SD15-0511
~~[illegible]~~ gm
1310 collect DNSTR-SD18-0511
1315 collect DNSTR-SD10-0511
1320 collect DNSTR-SD06-0511
Note at 1148 collected Dup for SD17.
- 1148 collect DNSTR-SD17P-0511
1325 mob to shore, unload boat, put samples in jars.
1400 M.OST to shore with samples selected for sieving
1415 SD08 - 4oz jar sieved - 18 pellets
SD13 - 4oz jar sieved - 0 pellets
SD14 - ↓ ↓ - 1 pellet
SD12 - - 0 pellets

Location Dam neck Date 5/10/11

Project / Client lake Tecumseh sedi sampling

SD20 - 4oz jar sieved - 2 pellets
SD18 - 4oz jar sieved - 0 pellets
SD19 - - 8 pellets
SD15 - - 0 pellets
SD05 - - 0 pellets
SD10 - - 0 pellets
SD06 - ↓ ↓ - 2 pellets
Sieve used was fine screen bucket P/N=190-E25, S/N=3010
~~1500 Begin to pack van~~ gm
~~1530 of~~
1455 collect DNSTR-EB051011
1500 collect DNSTR-FB051011 gm
1505 Begin to pack van
1530 offsite to buy ice & mob to office
1600 Begin packing cooler
1630 place cooler inside for FedEx pickup
1635 End of day

gm

Location dam neck Date 5/11/11

Project / Client lake Tecumsen sediment sampling

0800 meet at office
0845 dump trash at office
unpack van to make
room for boat - Mark
ships ponar back
0950 mob to job site
1020 arrive on site
1025 H&S brief - ticks, heavy lifting,
sun screen
1030 rinse boat, load boat
1040 offsite
1110 arrive @ office, unload.
boat in back of building
1130 Leave office, back to site
1210 arrive onsite; lunch
1330 Steve F & team arrive at
site, find concrete structure
in woods adjacent to parking lot
1405 collect [DNSTR-SS22-0511] for
PAHs only
1405 Steve F. finds pieces of clay
target
1410 collect [DNSTR-SS23-0511] for
PAHs

Location dam neck Date 5/11/11

Project / Client skeet & trap range soil sampling

1420 collect [DNSTR-SS24-0511] for
PAHs
1430 collect [DNSTR-SS25-0511] for
PAHs
Steve F. found mound w/
clay target chips on top near
SS 24
1435 mob out of woods w/ Steve
Mark & Adam locate sample
w/ GPS
1445 Mark & Adam out of woods
1500 Steve F & team offsite
1515 mob to office to pack
coolers
1550 arrive @ office

MC DE

TENTS

NCE | DATE

Location Dave Wech Date 6/14/14

Project / Client Pistol Range South

1251 Arrive onsite
Pers: ML OST
S. Eggerman
E. Dadzis
Wx: Sunny 90°F
obj: Collect Soil Samples
1252 Hold Safety Brief
Sign HASP
1253 Calibrate Mini RAE #
C102431
Fresh Air: 0 ppm
Span gas 100 ppm Isobutylene
= 101 ppm
1334 Markers out Pistol
1345 Range
~~1353~~ Collect $\boxed{\text{DNPRS-SS04-0610}}$
for metals from 6" bgs
1350 Collect $\boxed{\text{DNPRS-SS04P-0610}}$
for metals
1410 Collect $\boxed{\text{DNPRS-SS03-0610}}$
from 6" bgs metals
1416 Collect $\boxed{\text{DNPRS-SS08-0610}}$
from 6" bgs metals

Location: Dam Neck Date: 6/14/10
Project / Client: South Pistol Range Sampling

1423 Collect DNPRS-SS02-0610 from 6" bgs Metals
1435 Collect DNPRS-SS01-0610 from 6" bgs for Metals
1440 Collect DNPRS-SS06-0610 from 6" bgs for Metals
1446 Collect DNPS-SS05-0610 from 6" bgs for Metals
1454 Collect DNPS-SS07-0610 from 6" bgs for Metals
1640 Collect EB01-061410 for Metals
1700 offsite No Hits on PID

MLO 6/14/10

Location: Dam Neck Date: 6/15/10
Project / Client: Rifle Range Sampling

0900 Arrive onsite
Pers: M Lost S Eggerman
E. Davis
G. Mann
0901 Conduct Safety Brief
0905 Calibrate PID Ser#
C102431 100ppm Isobutylene
Fresh Air Cal: 0.0ppm
Isobutylene: 109 ppm
0950 Collect DNRR-SS01-0610 from 6" bgs Metals
0955 Collect DNRR-SS01P-0610 from 6" bgs metals
1017 Collect DNRR-SS02-0610 from 6" bgs metals
1018 Collect DNRR-SS02P-0610 from 6" bgs metals
1030 Collect DNRR-SS03-0610 from 6" bgs metals
1032 Collect DNRR-SS03P-0610 from 6" bgs metals
1040 Collect DNRR-SS04-0610 from ~~6"~~ 12" bgs metals SE

Location Dam Neck Rifle Range Date 6/15/10

Project / Client Sampling

1043 collect DNRR-SS04P-0610
from 12" bgs Metals

1100 collect DNRR-SS05-0610
from 12" bgs metals

1105 collect DNRR-SS05P-0610
from 12" bgs metals

1125 collect DNRR-SS06-0610
from 12" bgs Metals
collect MS/MSD

1154 collect DNRR-SS12-0610
from 12" bgs Metals

1205 collect DNRR-SS13-0610
~~DNRR-SS~~ ED
from 12" bgs metals

1215 collect DNRR-SS14-0610
from 12" bgs metals

1240 collect DNRR-SS16-0610
from 12" bgs metals

1245 collect DNRR-SS15-0610
from 12" bgs metals

1250 collect DNRR-SS15P-0610
from 12" bgs metals

1445 collect DNRR-SS~~16~~-0610 17
from 12" bgs metals

Location Dam Neck Pistol W Date 6/15/10

Project / Client Sampling

1455 Collect DNRR-SS18-0610
from 12" bgs metals
collect DNRR-SS20-0610

1507 from 12" bgs Metals

1510 collect DNRR-SS21-0610
from 12" bgs metals

1512 Collect DNRR-SS22-0610
from 12" bgs metals

1515 collect DNRR-SS19-0610
from 12" bgs metals

1520 collect DNRR-SS23-0610
from 12" bgs metals

1630 collect EB01-061510
for metals

1700 offsite

MK OS

Location: Dam Neck Date: 6/16/10
Project / Client: Pistol Range W

0900 Arrive onsite
Wx: Thunderstorms
Pers: MV OST
S Eggerman
G Moore
E Davis
} CH2M Hill
obj: Collect Soil Samples
0905 Held Safety Brief

1015 collect DNPRN-SS0~~4~~1-0610 (SE)
from 12" bgs metals
1017 Collect DNPRN-SS04-0610
from 12" bgs metals
1030 collect DNPRN-SS0~~8~~5-0610 (SE)
from 12" bgs metals
1035 collect DNPRN-SS03-0610
from 12" bgs metals
1045 collect DNPRN-SS08-0610
from 12" bgs metals
1100 collect DNPRN-SS06-0610
from 12" bgs metals
1105 collect DNPRN-SS07-0610
from 12" bgs metals

Location: Dam Neck Date: 6/16/10
Project / Client: Rifle / Pistol Range

1120 (SE) Collect DNPRN-SS09-0610
from 12" bgs metals
1125 collect DNPRN-SS10-0610
from 12" bgs metals
1135 collect DNPRN-SS12-0610
from 12" bgs metals
1150 collect DNPRN-SS17-0610
from 12" bgs metals
location biased towards debris
between S017 and S018
1114 collect DNPRN-SS18-0610
from 12" bgs metals
1115 collect DNPRN-SS18P-0610
from 12" bgs metals
1117 collect DNPRN-SS16-0610
from 12" bgs metals
1118 collect DNPRN-SS16P-0610
from 12" bgs metals
1127 collect DNPRN-SS11-0610
from 12" bgs metals
1128 collect DNPRN-SS11P-0610
from 12" bgs metals

Location Dam Neck Date 6/16/10
Project / Client Rifle Range

1134 Collect $\boxed{\text{DNPRN-SS14-0610}}$
from 12" bgs metals
1135 collect $\boxed{\text{DNPRN-SS14P-0610}}$
from 12" bgs metals
1137 collect $\boxed{\text{DNPRN-SS13-0610}}$
from 12" bgs metals
1200 collect $\boxed{\text{DNPRN-SS19-0610}}$
from 12" bgs metals
1205 collect $\boxed{\text{DNPRN-SS20-0610}}$
from 12" bgs metals
1417 collect $\boxed{\text{DNRR-SS09-0610}}$
from 12" bgs metals
1423 collect $\boxed{\text{DNRR-SS08-0610}}$
from 12" bgs metals
1430 Collect $\boxed{\text{DNRR-SS07-0610}}$
from 12" bgs metals
14~~4~~55 collect $\boxed{\text{DNRR-SS10-0610}}$
from 12" bgs metals
1459 collect $\boxed{\text{DNRR-SS11-0610}}$
from 12" bgs metals

Location Dam Neck Date 6/17/10
Project / Client Skeet Range

0823 Arrived Onsite
Personnel: MLOFT
S. Eggerman, G. Moore, E. Vakeize
Wx: Sunny 75°F
Obj: Collect Soil Samples
0826 Conduct Safety Brief
0830 Calibrate PID # C102431
Fresh Air: 0.0ppm
Isobutylene: 100ppm

0900 Collect $\boxed{\text{DNSTR-SS20-0610}}$
from 12" bgs metals
0910 Collect $\boxed{\text{DNSTR-SS07-0610}}$
from 12" bgs metals + PAHs
collect MS/MSD
0930 collect $\boxed{\text{DNSTR-SS21-0610}}$
from 12" bgs metals
0932 collect $\boxed{\text{DNSTR-SS19-0610}}$
from 12" bgs metals
1005 $\boxed{\text{collect DNSTR-SS18-0610}}$
from 12" bgs metals
1015 collect $\boxed{\text{DNSTR-SS16-0610}}$
from 12" bgs metals

Location DamNeck Date 6/17/10

Project / Client Skeet Range

1020 collect $\boxed{\text{DNSTR-SS15-0610}}$
from 12" bgs metals
collect $\boxed{\text{DNSTR-SS05-0610}}$
1030 from 12" bgs metals & PAH
1035 collect $\boxed{\text{DNSTR-SS06-0610}}$
from 12" bgs metals & PAH
1000 collect $\boxed{\text{DNSTR-SS17-0610}}$
from 12" bgs metals
1110 collect $\boxed{\text{DNSTR-SS14-0610}}$
from 12" bgs metals
1113 collect $\boxed{\text{DNSTR-SS13-0610}}$
from 12" bgs metals
collect $\boxed{\text{DNSTR-SS11-0610}}$
1150 from 12" bgs metals
1158 collect $\boxed{\text{DNSTR-SS12-0610}}$
from ~~bg~~ 12" bgs metals
1435 Collect $\boxed{\text{DNSTR-SS10-0610}}$
from 12" bgs metals
1435 collect $\boxed{\text{DNSTR-SS04-0610}}$ → + PAH
From 12" bgs metals & MS-MSD
1448 Collect $\boxed{\text{DNSTR-SS02-0610}}$
for Metal + PAH
1455 Collect $\boxed{\text{DNSTR-SS01-0610}}$ from 6" bgs → metals + PAH
1500 Collect $\boxed{\text{DNSTR-SS03-0610}}$ from 6" bgs

Location Dam Neck Date 6/17/10

Project / Client Skeet Range

1520 Collect $\boxed{\text{DNSTR-SS08-0610}}$
from 6" bgs metals
1535 collect $\boxed{\text{DNSTR-SS09-0610}}$
from 6" bgs metals
1652 collect $\boxed{\text{EB01-061710}}$
metals + PAH
1700 offsite

MW 6/17/10

Location Oceana/Fentress Date 6/18/10
Project / Client Bore Site Range

0600 Arrive onsite
Personnel: ML OST
S Eggerman, E. Chavez
Wx Sunny 90°
obj Sample Backstop
of Bore Site Range
0630 Calibrate PID
Ser # C102431
Fresh Air: 0.0ppm
Isobutylene: 101 ppm
0700 Hold Safety Brief

0900 collect $\boxed{\text{OFMGBR - SS02 - 0610}}$
from 12" bgs metals
0905 collect $\boxed{\text{OFMGBR - SB02 - 0610}}$
from 12-24" into berm metals
0910 collect $\boxed{\text{OFMGBR - SS01 - 0610}}$
from 12" bgs metals
0915 collect $\boxed{\text{OFMGBR - SB01 - 0610}}$
from 12-24" into berm metals
0925 collect $\boxed{\text{OFMGBR - SS03 - 0610}}$
from 12" bgs metals
0927 collect $\boxed{\text{OFMGBR - SB03 - 0610}}$
from 12-24" into berm metals

↳ collect MS/MSD

Location Oceana/Fentress Date 6/18/10
Project / Client Boresite Range

0935 Collect $\boxed{\text{OFMGBR-SS04-0610}}$
from 12" bgs metals
0940 collect $\boxed{\text{OFMGBR-SB04-0610}}$
from 12-24" into berm
0948 collect $\boxed{\text{OFMGBR-SS05-0610}}$
from 12" bgs metals
0950 collect $\boxed{\text{OFMGBR-SB05-0610}}$
from 12-24" into berm metals
0951 collect $\boxed{\text{OFMGBR-SS06-0610}}$
from 12" bgs metals
0952 collect $\boxed{\text{OFMGBR-SB06-0610}}$
from 12-24" into berm metals
0955 Collect $\boxed{\text{OFMGBR-SS07-0610}}$
from 12" bgs metals
1000 collect $\boxed{\text{OFMGBR-SB07-0610}}$
from 12-24" into berm metals
0959 collect $\boxed{\text{OFMGBR-SS08-0610}}$
from 12" bgs metals
collect MS/MSD
1019 collect $\boxed{\text{OFMGBR-SB08-0610}}$
from 12-24" into berm metals
1300 Arrive at NAS Oceana

Location: Oceana / Fentress Date: 6/18/10

Project / Client: Boresight Ranges

	S02
1320	collect OCMGBR-S[illegible] -0610
	from 12" bgs metals
1323	Collect OCMGBR-SB02-0610
	from 12-24" into berm metals
1325	Collect OCMGBR-SS01-0610
	from 12" bgs metals
1330	Collect OCMGBR-SB01-0610
	from 12-24" into berm metals
1335	Collect OCMGBR-SS03-0610
	from 12" bgs for metals
1340	Collect OCMGBR-SB03-0610
	from 12-24" bgs for metals
1345	Collect OCMGBR-SS04-0610
	from 12" bgs for metals
1350	Collect OCMGBR-SB04-0610
	from 12-24" into berm for metals
1355	collect OCMGBR-SS05-0610
	from 12" bgs for metals
1400	collect OCMGBR-SB05-0610
	from 12-24" into berm for metals
1405	collect OCMGBR-SS06-0610
	from 12" bgs for metals
1410	collect OCMGBR-SB06-0610
	from 12-24" bgs for metals

Location: Oceana / Fentress Date: 6/18/10

Project / Client: Boresight Ranges

1415	Collect OCMGBR-SS07-0610
	from 12" bgs for metals
1420	collect OCMGBR-SB07-0610
	from 12-24" into berm for metals
1425	collect OCMGBR-SS08-0610
	from 12" bgs for metals
1430	collect OCMGBR-SB08-0610
	from 12-24" into berm for metals
1530	collect EB01-061810
1600	Ship Samples
1700	Offsite

[illegible]

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

10614

Send Results to:	Send Invoice to:
Name Victoria Bryn Idron	Name
Company CH2M HILL	Company
Address	Address
City Virginia Beach	City
State, Zip VA	State, Zip
Phone 757-671-6252	Phone
Fax	Fax
E-mail victoria.bryn.idron@ch2m.com	E-mail
Project No./Name: NAS Oceana	**Sampler's (Signature):**

Analysis Requirements: 6010B - lead, antimony, arsenic, copper, nickel, zinc

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #:

CAR #:

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B	Comments	No. of Bottles	*Lab Use Only* Containers/Pres.
	6/14 1345	DNPRS-SS04-0610	SS	X	Hold for analysis		
	6/14 1350	DNPRS-SS04P-0610	SS	X	Hold		
	6/14 1410	DNPRS-SS03-0610	SS	X			
	6/14 1416	DNPRS-SS08-0610	SS	X	Hold		
	6/14 1423	DNPRS-SS02-0610	SS	X			
	6/14 1435	DNPRS-SS01-0610	SS	X			
	6/14 1440	DNPRS-SS06-0610	SS	X	Hold		
	6/14 1446	DNPRS-SS05-0610	SS	X	Hold		
	6/14 1454	DNPRS-SS07-0610	SS	X	Hold		
	6/14 1640	EB04-061410	EB	X			
	6/15 0950	DNRR-SS01-0610	SS	X			
	6/15 0955	DNRR-SS01P-0610	SS	X			

Sample Kit Prep'd by: (Signature)	Date/Time	Received By: (Signature)
Relinquished by: (Signature)	Date/Time 6/16/10 0700	Received By: (Signature)
Relinquished by: (Signature)	Date/Time	Received By: (Signature)
Received for Laboratory by: (Signature)	Date/Time	*Temperature*

REMARKS:

Fed Ex

Details:

Page 3 of 3

Cooler No. 1 of 1

Date Shipped 6/16

Shipped By

Turnaround

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

10615

Send Results to:	Send Invoice to:	Analysis Requirements:	Lab Use Only:
Name Victoria Brynildsen Company CH2MHILL Address City Virginia Beach State, Zip VA Phone 757-671-6252 Fax E-mail Victoria.brynildsen@CH2M.com	Name Company Address City State, Zip Phone Fax E-mail	6010B - lead, antimony, arsenic, copper, nickel, zinc	VOA Headspace Y N NA Field Filtered Y N NA Correct Containers Y N NA Discrepancies Y N NA Cust. Seals Intact Y N NA Containers Intact Y N NA Airbill #: CAR #:
Project No./Name: NAS Oceana	Sampler's (Signature):		

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B	Comments	No. of Bottles	Lab Use Only Containers/Pres.
	6/15/10 1017	DNRR-SS02-0610	SS	X			
	6/15/10 1020	DNRR-SS02P-0610	SS	X			
	6/15/10 1030	DNRR-SS03-0610	SS	X			
	6/15/10 1032	DNRR-SS03P-0610	SS	X			
	6/15/10 1040	DNRR-SS04-0610	SS	X			
	6/15/10 1045	DNRR-SS04P-0610	SS	X			
	6/15/10 1100	DNRR-SS05-0610	SS	X			
	6/15/10 1105	DNRR-SS05P-0610	SS	X			
	[illegible]	DNRR-SS06-0610	SS	X			
	6/15/10 1154	DNRR-SS12-0610	SS	X			
	6/15/10 1205	DNRR-SS13-0610	SS	X			
	6/15/10 1215	DNRR-SS14-0610	SS	X			

Signature	Date/Time	Received By
Sample Kit Prep'd by: (Signature)	6/16/10 0700	Received By: (Signature)
Relinquished by: (Signature)	6/16/10 0700	Received By: (Signature)
Relinquished by: (Signature)	Date/Time	Received By: (Signature)
Received for Laboratory by: (Signature)	Date/Time	*Temperature*

REMARKS:

FED EX

Details:
Page 2 of 3
Cooler No. 1 of 1
Date Shipped 6/16
Shipped By [illegible]
Turnaround [illegible]

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

10616

Send Results to:	Send Invoice to:
Name Victoria Brynildsen	Name
Company CH2MHILL	Company
Address	Address
City Virginia Beach	City
State, Zip VA	State, Zip
Phone 757 671-6252	Phone
Fax	Fax
E-mail victoria.brynildsen@ch2m.com	E-mail
Project No./Name: NAS Oceana	**Sampler's (Signature):**

Analysis Requirements: 6010B - lead, antimony, arsenic, copper, nickel, zinc

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #:

CAR #:

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B	Comments	No. of Bottles	*Lab Use Only* Containers/Pres.
	6/15/10 1240	DNRR-SS16-0610	SS	X			
	6/15/10 1245	DNRR-SS15-0610	SS	X			
	6/15/10 1250	DNRR-SS15P-0610	SS	X			
	6/15/10 1405	DNRR-SS17-0610	SS	X			
	6/15/10 1455	DNRR-SS18-0610	SS	X			
	6/15/10 1507	DNRR-SS20-0610	SS	X			
	6/15/10 1510	DNRR-SS21-0610	SS	X			
	6/15/10 1512	DNRR-SS22-0610	SS	X			
	6/15/10 1515	DNRR-SS19-0610	SS	X			
	6/15/10 1520	DNRR-SS22-0610	SS	X			
	6/15/10 1630	EB01-061510	EB	X			

	Date/Time	
Sample Kit Prep'd by: (Signature)	6/16/10 0700	Received By: (Signature)
Relinquished by: (Signature)	6/16/10 0700	Received By: (Signature)
Relinquished by: (Signature)	Date/Time	Received By: (Signature)
Received for Laboratory by: (Signature)	Date/Time	*Temperature*

REMARKS:

FedEx

Details:

Page 1 of 3

Cooler No. 1 of 1

Date Shipped 6/16

Shipped By

Turnaround

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

10617

Send Results to:	Send Invoice to:	Analysis Requirements:	Lab Use Only:
Name Victoria Brynildsen Company CH2M HILL Address City Virginia Beach State, Zip VA Phone 757-671-6252 Fax E-mail	Name Company Address City State, Zip Phone Fax E-mail	6010B (lead only); PAHs CTO WE03	VOA Headspace Y N NA Field Filtered Y N NA Correct Containers Y N NA Discrepancies Y N NA Cust. Seals Intact Y N NA Containers Intact Y N NA Airbill #: CAR #:
Project No./Name:	Sampler's (Signature):		

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B (lead only)	PAHs											Comments	No. of Bottles	Lab Use Only Containers/Pres.
	6/17 0900	DNSTR-SS20-0610		X														
	6/17 0910	DNSTR-SS07-0610		X	X											Run MS/MSD		
	6/17 0930	DNSTR-SS21-0610		X														
	6/17 0932	DNSTR-SS19-0610		X														
	6/17 1005	DNSTR-SS18-0610		X														
	6/17 1015	DNSTR-SS16-0610		X														
	6/17 1020	DNSTR-SS15-0610		X														
	6/17 1030	DNSTR-SS05-0610		X	X													
	6/17 1035	DNSTR-SS06-0610		X	X													
	6/17 1000	DNSTR-SS17-0610		X														
	6/17 1110	DNSTR-SS14-0610		X														
	6/17 1113	DNSTR-SS13-0610		X														

Signature	Date/Time	Received By: (Signature)
Sample Kit Prep'd by: (Signature)	Date/Time	Received By: (Signature)
Relinquished by: (Signature) [signature]	Date/Time 6/18 1600	Received By: (Signature)
Relinquished by: (Signature)	Date/Time	Received By: (Signature)
Received for Laboratory by: (Signature)	Date/Time	*Temperature*

REMARKS:

Details:

Page 1 of 2

Cooler No. 1 of 2

Date Shipped 6/18

Shipped By FedEx

Turnaround NL

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

10618

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

Send Results to:	**Send Invoice to:**
Name Victoria Bryeldsen	Name
Company CH2M HILL	Company
Address	Address
City Virginia Beach VA	City
State, Zip VA	State, Zip
Phone	Phone
Fax	Fax
E-mail	E-mail
Project No./Name: Dam Neck	**Sampler's (Signature):** [signature]

Analysis Requirements: 6010B - [illegible]

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #:

CAR #:

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B	Comments	No. of Bottles	*Lab Use Only* Containers/Pres.
	6/18 0900	OFMGBR-SS02-0610	SS	X		1	
	6/18 0905	OFMGBR-SB02-0610	SS	X		1	
	6/18 0910	OFMGBR-SS01-0610	SS	X		1	
	6/18 0915	OFMGBR-SB01-0610	SS	X	MS/MSD	3	
	6/18 0925	OFMGBR-SS03-0610	SS	X		1	
	6/18 0927	OFMGBR-SB03-0610	SS	X		1	
	6/18 0935	OFMGBR-SS04-0610	SS	X		1	
	6/18 0940	OFMGBR-SB04-0610	SS	X		1	
	6/18 0948	OFMGBR-SS05-0610	SS	X		1	
	6/18 0950	OFMGBR-SB05-0610	SS	X		1	
	6/18 0951	OFMGBR-SS06-0610	SS	X		1	
	6/18 0952	OFMGBR-SB06-0610	SS	X		1	

Sample Kit Prep'd by: (Signature)	Date/Time	Received By: (Signature)
Relinquished by: (Signature) [signature] 6/18/10	Date/Time 1800	Received By: (Signature)
Relinquished by: (Signature)	Date/Time	Received By: (Signature)
Received for Laboratory by: (Signature)	Date/Time	*Temperature*

REMARKS:

CTO WE07

Details:

Page 3 of 3

Cooler No. 1 of 1

Date Shipped 6/18

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Turnaround

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

10619

Send Results to:	**Send Invoice to:**
Name Victoria Bryntlson	Name
Company	Company
Address	Address
City	City
State, Zip	State, Zip
Phone	Phone
Fax	Fax
E-mail	E-mail
Project No./Name: Dam Neck	**Sampler's (Signature):** [illegible]

Analysis Requirements: 6010B Lead Antimony [illegible]

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #:

CAR #:

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B Lead Antimony [illegible]	Comments	No. of Bottles	*Lab Use Only* Containers/Pres.
	6/18 0955	OFMGBR-SS07-0610	SS	X		1	
	6/18 1000	OFMGBR-SB07-0610	SS	X		1	
	6/18 0959	OFMGBR-SS08-0610	SS	X	MS/MSD	3	
	6/18 1019	OFMGBR-SB08-0610	SS	X		1	
	6/18 ~~1300~~ 1320	OCMGBR-SS02-0610	SS	X		1	
	6/18 1323	OCMGBR-SB02-0610	SS	X		1	
	6/18 1325	OCMGBR-SS01-0610	SS	X		1	
	6/18 1330	OCMGBR-SB01-0610	SS	X		1	
	6/18 1335	OCMGBR-SS03-0610	SS	X		1	
	6/18 1340	OCMGBR-SB03-0610	SS	X		1	
	6/18 1345	OCMGBR-SS04-0610	SS	X		1	
	6/18 1350	OCMGBR-SB04-0610	SS	X		1	

	Date/Time	
Sample Kit Prep'd by: (Signature)		Received By: (Signature)
Relinquished by: (Signature) [illegible]	6/18/10 1600	Received By: (Signature)
Relinquished by: (Signature)		Received By: (Signature)
Received for Laboratory by: (Signature)		*Temperature*

REMARKS:

CTO WE03

Details:

Page 1 of 3

Cooler No. 1 of 1

Date Shipped 6/18

Shipped By FedX

Turnaround [illegible]

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

10627

Send Results to:	Send Invoice to:
Name Victoria Brinkley[illegible]	Name
Company CH2M Hill	Company
Address	Address
City	City
State, Zip	State, Zip
Phone	Phone
Fax	Fax
E-mail	E-mail
Project No./Name: Dam Neck	Sampler's (Signature): [signature]

Analysis Requirements: 6010B [illegible]

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #:

CAR #:

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B	Comments	No. of Bottles	*Lab Use Only* Containers/Pres.
	6/18 1355	OCMGBR-SS05-0610	SO	X		1	
	6/18 1400	OCMGBR-SB05-0610		X		1	
	6/18 1405	OCMGBR-SS06-0610		X		1	
	6/18 1410	OCMGBR-SB06-0610		X		1	
	6/18 1415	OCMGBR-SS07-0610		X		1	
	6/18 1420	OCMGBR-SB07-0610		X		1	
	6/18 1425	OCMGBR-SS08-0610		X		1	
	6/18 1430	OCMGBR-SB08-0610		X		1	
	6/18 1530	~~[illegible]~~ EB01-061810		X		1	

Sample Kit Prep'd by: (Signature)	Date/Time	Received By: (Signature)	
Relinquished by: (Signature) [signature]	Date/Time 6/18/10 1610	Received By: (Signature)	
Relinquished by: (Signature)	Date/Time	Received By: (Signature)	
Received for Laboratory by: (Signature)	Date/Time	*Temperature*	

REMARKS:

CTO WE03

Details:

Page 2 of 3

Cooler No. 1 of 1

Date Shipped 6/18

Shipped By FedEx

Turnaround [illegible]

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

10628

Send Results to:	Send Invoice to:
Name Victoria Bruntdsen	Name
Company CH2M Hill	Company
Address	Address
City Virginia Beach	City
State, Zip VA	State, Zip
Phone 757-671-6252	Phone
Fax	Fax
E-mail	E-mail
Project No./Name:	Sampler's (Signature):

Analysis Requirements: 6010B (lead only); PAHs

CTO WE03

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #:

CAR #:

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B (lead only)	PAHs	Comments	No. of Bottles	*Lab Use Only* Containers/Pres.
	6/17 1150	DNSTR-SS11-0610	SS	X				
	6/17 1158	DNSTR-SS12-0610	SS	X				
	6/17 1435	DNSTR-SS10-0610	SS	X				
	6/17 1435	DNSTR-SS04-0610	SS	X	X	Run MS/MSD		
	6/17 1448	DNSTR-SS02-0610	SS	X	X			
	6/17 1455	DNSTR-SS01-0610	SS	X	X			
	6/17 1500	DNSTR-SS03-0610	SS	X	X			
	6/17 1520	DNSTR-SS08-0610	SS	X				
	6/17 1535	DNSTR-SS09-0610	SS	X				
	6/17 1652	EB01-061710	EB	X	X			

Sample Kit Prep'd by: (Signature) LS	Date/Time	Received By: (Signature)	REMARKS:
Relinquished by: (Signature)	Date/Time 6/18 1600	Received By: (Signature)	
Relinquished by: (Signature)	Date/Time	Received By: (Signature)	
Received for Laboratory by: (Signature)	Date/Time	*Temperature*	

Details:

Page 1 of 2

Cooler No. 1 of 2

Date Shipped 6/18

Shipped By CSJ

Turnaround R

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

10629

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

Send Results to:

Name Victoria Brynildsen
Company CH2M Hill
Address
City Virginia Beach,
State, Zip VA
Phone 757-671-6252
Fax
E-mail victoria.brynildsen@ch2m.com

Project No./Name:

Send Invoice to:

Name
Company
Address
City
State, Zip
Phone
Fax
E-mail

Sampler's (Signature):

Analysis Requirements:

6010B - [illegible]

CTO WE03

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #:

CAR #:

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B												Comments	No. of Bottles	*Lab Use Only* Containers/Pres.
	6/16 1430	DNRR-SS07-0610	SS	X														
	6/16 1455	DNRR-SS10-0610	SS	X														
	6/16 1459	DNRR-SS11-0610	SS	X														
	6/16 1716	EB02-06/16/10	EB	X														
	6/16 1710	EB01-6/16/10	EB	X														

Signature	Date/Time	Received By
Sample Kit Prep'd by: (Signature) LS	Date/Time	Received By: (Signature)
Relinquished by: (Signature) [signature]	Date/Time 6/18 1610	Received By: (Signature)
Relinquished by: (Signature)	Date/Time	Received By: (Signature)
Received for Laboratory by: (Signature)	Date/Time	*Temperature*

REMARKS:

Details:

Page 1 of 3
Cooler No. 1 of 1
Date Shipped 6/18
Shipped By FedEx
Turnaround PL

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

10630

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

Send Results to:	**Send Invoice to:**	**Analysis Requirements:**	**Lab Use Only:**
Name Victoria Brynildsen Company CH2M HILL Address City Virginia Beach State, Zip VA Phone 757-671-6252 Fax E-mail victoria.brynildsen@ch2m.com	Name Company Address City State, Zip Phone Fax E-mail	6010B CTO WE03	VOA Headspace Y N NA Field Filtered Y N NA Correct Containers Y N NA Discrepancies Y N NA Cust. Seals Intact Y N NA Containers Intact Y N NA Airbill #: CAR #:
Project No./Name:	**Sampler's (Signature):**		

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B	Comments	No. of Bottles	*Lab Use Only* Containers/Pres.
	6/16 1115	DNPRN-SS18P-0610	SS	X			
	6/16 1117	DNPRN-SS16-0610	SS	X			
	6/16 1118	DNPRN-SS16P-0610	SS	X			
	6/16 1127	DNPRN-SS11-0610	SS	X			
	6/16 1128	DNPRN-SS11P-0610	SS	X			
	6/16 1134	DNPRN-SS14-0610	SS	X			
	6/16 1135	DNPRN-SS14P-0610	SS	X			
	6/16 1137	DNPRN-SS13-0610	SS	X			
	6/16 1200	DNPRN-SS19-0610	SS	X			
	6/16 1205	DNPRN-SS20-0610	SS	X			
	6/16 1417	DNRR-SS09-0610	SS	X			
	6/16 1423	DNRR-SS08-0610	SS	X			

Signature	Date/Time	Received By: (Signature)
Sample Kit Prep'd by: (Signature) WS		
Relinquished by: (Signature)	6/18	
Relinquished by: (Signature)		
Received for Laboratory by: (Signature)		*Temperature*

REMARKS:

Details:
Page 3 of 3
Cooler No. 1 of 1
Date Shipped 6/18
Shipped By FedEx
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Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 615-345-1115 ♦ (fax) 615-846-5426

10631

Send Results to:	Send Invoice to:
Name Victoria Brynildsen	Name
Company CH2M Hill	Company
Address	Address
City	City
State, Zip Virginia Beach, VA	State, Zip
Phone 757-671-6252	Phone
Fax	Fax
E-mail victoria.brynildsen@ch2m.com	E-mail
Project No./Name:	**Sampler's (Signature):**

Analysis Requirements: 6010B - Antimony, Copper, Lead, Zinc

CTO WE03

Lab Use Only:	Y	N	NA
VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #:

CAR #:

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	6010B	Comments	No. of Bottles	*Lab Use Only* Containers/Pres.
	6/16 1015	DNPRN-SS01-0610	SS	X			
	6/16 1017	DNPRN-SS04-0610	SS	X			
	6/16 1030	DNPRN-SS05-0610	SS	X			
	6/16 1035	DNPRN-SS03-0610	SS	X			
	6/16 1045	DNPRN-SS08-0610	SS	X			
	6/16 1100	DNPRN-SS06-0610	SS	X			
	6/16 1105	DNPRN-SS07-0610	SS	X			
	6/16 1120	DNPRN-SS09-0610	SS	X			
	6/16 1125	DNPRN-SS10-0610	SS	X			
	6/16 1135	DNPRN-SS12-0610	SS	X			
	6/16 1150	DNPRN-SS17-0610	SS	X			
	6/16 1114	DNPRN-SS18-0610	SS	X			

	Date/Time	
Sample Kit Prep'd by: (Signature) WS	Date/Time	Received By: (Signature)
Relinquished by: (Signature) [signature]	6/18 1600	Received By: (Signature)
Relinquished by: (Signature)	Date/Time	Received By: (Signature)
Received for Laboratory by: (Signature)	Date/Time	*Temperature*

REMARKS:

Details:

Page 2 of 2

Cooler No. 1 of 1

Date Shipped 6/18

Shipped By FedEx

Turnaround SL

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

Appendix B
Data Validation Reports

MEMORANDUM CH2MHILL

Data Validation Summary

CTO-WE03 Oceana

TO:	Anita Dodson/VBO
	Megan Morrison/WDC
FROM:	Tiffany McGlynn/GNV
CC:	Herb Kelly/GNV
DATE:	August 27th, 2010

Introduction

The following data validation report discusses the data validation process and findings for Empirical Laboratories SDG 1006139.

Samples were analyzed using the following analytical methods:

- SW6010B Metals

The samples included in this SDG are listed in the table below.

Sample Name	Lab Sample ID	Matrix	Metals
DNRR-SS16-0610	1006139-01	Soil	X
DNRR-SS15-0610	1006139-02	Soil	X
DNRR-SS15P-0610	1006139-03	Soil	X
DNRR-SS17-0610	1006139-04	Soil	X
DNRR-SS18-0610	1006139-05	Soil	X
DNRR-SS20-0610	1006139-06	Soil	X
DNRR-SS21-0610	1006139-07	Soil	X
DNRR-SS22-0610	1006139-08	Soil	X
DNRR-SS19-0610	1006139-09	Soil	X
EB01-061510	1006139-11	Water	X
DNRR-SS02-0610	1006139-12	Soil	X
DNRR-SS02P-0610	1006139-13	Soil	X
DNRR-SS03-0610	1006139-14	Soil	X
DNRR-SS03P-0610	1006139-15	Soil	X
DNRR-SS04-0610	1006139-16	Soil	X
DNRR-SS04P-0610	1006139-17	Soil	X
DNRR-SS05-0610	1006139-18	Soil	X
DNRR-SS05P-0610	1006139-19	Soil	X
DNRR-SS06-0610	1006139-20	Soil	X
DNRR-SS12-0610	1006139-21	Soil	X
DNRR-SS13-0610	1006139-22	Soil	X
DNRR-SS14-0610	1006139-23	Soil	X
DNPRS-SS03-0610	1006139-26	Soil	X
DNPRS-SS02-0610	1006139-28	Soil	X
DNPRS-SS01-0610	1006139-29	Soil	X
EB01-061410	1006139-33	Water	X
DNRR-SS01-0610	1006139-34	Soil	X
DNRR-SS01P-0610	1006139-35	Soil	X

Data Evaluation

Data was evaluated in accordance with the analytical methods and with the criteria found in the following guidance documents; National Functional Guidelines for Inorganic Methods Data Review (EPA 2004) and Region III Modifications for Inorganic Data Review (EPA 1993), as applicable. The samples were evaluated based on the following criteria:

- Data Completeness
- Technical Holding Times
- Initial/Continuing Calibrations

- Blanks
- Internal Standards
- Serial Dilutions
- Laboratory Control Samples
- Matrix Spike Recoveries
- Identification/Quantitation
- Reporting Limits

Overall Evaluation of Data/Potential Usability Issues

Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. If an issue is not addressed there were no actions required based on unmet quality criteria. When more than one qualifier is associated with a compound/analyte, the validator has chosen the qualifier that best indicates possible bias in the results and qualified these data accordingly.

Data Completeness

The SDG was received complete and intact. Resubmissions were not required.

Technical Holding Times

According to the chain of custody records, sampling was performed on 6/14/10 and 6/15/10. Samples were received at the laboratory on 6/17/10. All sample preparation analysis was performed within holding time requirements.

Blanks

Various detects were found in the equipment blanks and method blanks. Qualified data are summarized in **Attachment 1.**

Matrix Spike/Spike Duplicate

Antimony exhibited recoveries below the lower control limits for sample DNRR-SS06-0610. Qualified data are summarized in **Attachment 1**.

Conclusion

These data can be used in the project decision-making process as qualified by the data quality evaluation process.

Please do not hesitate to contact us about this validation report.

Sincerely,

Tiffany McGlynn

Qualification Flags

Exclude	More appropriate data exist for this analyte.
R	Data were rejected for use.
UL	Analyte not detected, quantitation limit is potentially biased low.
UJ	Analyte not detected, estimated quantitation limit.
U	Analyte not detected.
B	Not detected substantially above the level reported in laboratory or field blanks.
L	Analyte present, estimated value potentially biased low.
K	Analyte present, estimated value potentially biased high.
N	Analyte identification presumptive; no second column analysis performed or GC/MS tentative identification.
J	Analyte present, estimated value.
NJ	Analysis indicates the presence of an analyte that was "tentatively identified" and the associated value represents its approximate concentration.
None	Placeholder for calculating quality control issues that do not require flagging.
=	Analyte was detected at a concentration greater than the quantitation limit.

Qualifier Code Reference

Value	Description
%SOL	High Moisture content
2C	Second Column – Poor Dual Column Reproducibility
2S	Second Source – Bad reproducibility between tandem detectors
BD	Blank Spike/Blank Spike Duplicate(LCS/LCSD) Precision
BRL	Below Reporting Limit
BSH	Blank Spike/LCS – High Recovery
BSL	Blank Spike/LCS – Low Recovery
CC	Continuing Calibration
CCH	Continuing Calibration Verification – High Recovery
CCL	Continuing Calibration Verification – Low Recovery
DL	Redundant Result – due to Dilution
EBL	Equipment Blank Contamination
EMPC	Estimated Possible Maximum Concentration
ESH	Extraction Standard - High Recovery
ESL	Extraction Standard - Low Recovery
FBL	Field Blank Contamination
FD	Field Duplicate
HT	Holding Time
ICB	Initial Calibration – Bad Linearity or Curve Function
ICH	Initial Calibration – High Relative Response Factors
ICL	Initial Calibration – Low Relative Response Factors
ISH	Internal Standard – High Recovery
ISL	Internal Standard – Low Recovery
LD	Lab Duplicate Reproducibility
LR	Concentration Exceeds Linear Range
MBL	Method Blank Contamination
MDP	Matrix Spike/Matrix Spike Duplicate Precision
MI	Matrix interference obscuring the raw data
MSH	Matrix Spike and/or Matrix Spike Duplicate – High Recovery
MSL	Matrix Spike and/or Matrix Spike Duplicate – Low Recovery
OT	Other
PD	Pesticide Degradation

Value	Description
RE	Redundant Result - due to Reanalysis or Re-extraction
SD	Serial Dilution Reproducibility
SSH	Spiked Surrogate – High Recovery
SSL	Spiked Surrogate – Low Recovery
TBL	Trip Blank Contamination
TN	Tune

CTO-WE03 Oceana
Attachment 1 Change Qual. Table
SDG 1006139

Sample ID	Compound	Q Flag	Qual Code
DNRR-SS18-0610	Nickel	B	EBL
DNRR-SS20-0610	Nickel	B	EBL
DNRR-SS20-0610	Zinc	B	MBL
DNRR-SS21-0610	Nickel	B	EBL
DNRR-SS21-0610	Zinc	B	MBL
DNRR-SS22-0610	Zinc	B	MBL
DNRR-SS19-0610	Nickel	B	EBL
DNRR-SS19-0610	Zinc	B	MBL
DNRR-SS06-0610	Antimony	L	MSL
DNRR-SS12-0610	Nickel	B	EBL

M E M O R A N D U M CH2MHILL

Data Validation Summary

CTO-WE03 Oceana

TO: Anita Dodson/VBO

Megan Morrison/WDC

FROM: Tiffany McGlynn/GNV

CC: Herb Kelly/GNV

DATE: August 27th, 2010

Introduction

The following data validation report discusses the data validation process and findings for Compuchem Laboratories SDG 1006152.

Samples were analyzed using the following analytical methods:

- SW6010B Metals
- SW8270C Semivolatiles PAHs

The samples included in this SDG are listed in the table below.

Sample Name	Lab Sample ID	Matrix	Metals	PAHS
DNSTR-SS20-0610	1006152-01	Soil	X	
DNSTR-SS07-0610	1006152-02	Soil	X	X
DNSTR-SS21-0610	1006152-03	Soil	X	
DNSTR-SS19-0610	1006152-04	Soil	X	
DNSTR-SS18-0610	1006152-05	Soil	X	
DNSTR-SS16-0610	1006152-06	Soil	X	
DNSTR-SS15-0610	1006152-07	Soil	X	
DNSTR-SS05-0610	1006152-08	Soil	X	X
DNSTR-SS06-0610	1006152-09	Soil	X	X
DNSTR-SS17-0610	1006152-10	Soil	X	
DNSTR-SS14-0610	1006152-11	Soil	X	
DNSTR-SS13-0610	1006152-12	Soil	X	

Sample Name	Lab Sample ID	Matrix	Metals	PAHS
DNSTR-SS11-0610	1006152-13	Soil	X	
DNSTR-SS12-0610	1006152-14	Soil	X	
DNSTR-SS10-0610	1006152-15	Soil	X	
DNSTR-SS04-0610	1006152-16	Soil	X	X
DNSTR-SS02-0610	1006152-17	Soil	X	X
DNSTR-SS01-0610	1006152-18	Soil	X	X
DNSTR-SS03-0610	1006152-19	Soil	X	X
DNSTR-SS08-0610	1006152-20	Soil	X	
DNSTR-SS09-0610	1006152-21	Soil	X	
EB01-061710	1006152-22	Water	X	X
OFMGBR-SS07-0610	1006152-23	Soil	X	
OFMGBR-SB07-0610	1006152-24	Soil	X	
OFMGBR-SS08-0610	1006152-25	Soil	X	
OFMGBR-SB08-0610	1006152-26	Soil	X	
OCMGBR-SS02-0610	1006152-27	Soil	X	
OCMGBR-SB02-0610	1006152-28	Soil	X	
OCMGBR-SS01-0610	1006152-29	Soil	X	
OCMGBR-SB01-0610	1006152-30	Soil	X	
OCMGBR-SS03-0610	1006152-31	Soil	X	
OCMGBR-SB03-0610	1006152-32	Soil	X	
OCMGBR-SS04-0610	1006152-33	Soil	X	
OCMGBR-SB04-0610	1006152-34	Soil	X	
OCMGBR-SS05-0610	1006152-35	Soil	X	
OCMGBR-SB05-0610	1006152-36	Soil	X	
OCMGBR-SS06-0610	1006152-37	Soil	X	
OCMGBR-SB06-0610	1006152-38	Soil	X	
OCMGBR-SS07-0610	1006152-39	Soil	X	
OCMGBR-SB07-0610	1006152-40	Soil	X	
OCMGBR-SS08-0610	1006152-41	Soil	X	
OCMGBR-SB08-0610	1006152-42	Soil	X	
EB01-061810	1006152-43	Water	X	
OFMGBR-SS02-0610	1006152-44	Soil	X	
OFMGBR-SB02-0610	1006152-45	Soil	X	
OFMGBR-SS01-0610	1006152-46	Soil	X	
OFMGBR-SB01-0610	1006152-47	Soil	X	
OFMGBR-SS03-0610	1006152-48	Soil	X	
OFMGBR-SB03-0610	1006152-49	Soil	X	
OFMGBR-SS04-0610	1006152-50	Soil	X	
OFMGBR-SB04-0610	1006152-51	Soil	X	
OFMGBR-SS05-0610	1006152-52	Soil	X	
OFMGBR-SB05-0610	1006152-53	Soil	X	
OFMGBR-SS06-0610	1006152-54	Soil	X	

Sample Name	Lab Sample ID	Matrix	Metals	PAHS
OFMGBR-SB06-0610	1006152-55	Soil	X	
DNRR-SS07-0610	1006152-56	Soil	X	
DNRR-SS10-0610	1006152-57	Soil	X	
DNRR-SS11-0610	1006152-58	Soil	X	
EB02-061610	1006152-59	Water	X	
EB01-061610	1006152-60	Water	X	
DNPRN-SS01-0610	1006152-61	Soil	X	
DNPRN-SS04-0610	1006152-62	Soil	X	
DNPRN-SS05-0610	1006152-63	Soil	X	
DNPRN-SS03-0610	1006152-64	Soil	X	
DNPRN-SS08-0610	1006152-65	Soil	X	
DNPRN-SS06-0610	1006152-66	Soil	X	
DNPRN-SS07-0610	1006152-67	Soil	X	
DNPRN-SS09-0610	1006152-68	Soil	X	
DNPRN-SS10-0610	1006152-69	Soil	X	
DNPRN-SS12-0610	1006152-70	Soil	X	
DNPRN-SS17-0610	1006152-71	Soil	X	
DNPRN-SS18-0610	1006152-72	Soil	X	
DNPRN-SS18P-0610	1006152-73	Soil	X	
DNPRN-SS16-0610	1006152-74	Soil	X	
DNPRN-SS16P-0610	1006152-75	Soil	X	
DNPRN-SS11-0610	1006152-76	Soil	X	
DNPRN-SS11P-0610	1006152-77	Soil	X	
DNPRN-SS14-0610	1006152-78	Soil	X	
DNPRN-SS14P-0610	1006152-79	Soil	X	
DNPRN-SS13-0610	1006152-80	Soil	X	
DNPRN-SS19-0610	1006152-81	Soil	X	
DNPRN-SS20-0610	1006152-82	Soil	X	
DNRR-SS09-0610	1006152-83	Soil	X	
DNRR-SS08-0610	1006152-84	Soil	X	

Data Evaluation

Data was evaluated in accordance with the analytical methods and with the criteria found in the following guidance documents: National Functional Guidelines for Superfund Organic Methods Data Review (EPA 2008), National Functional Guidelines for Inorganic Methods Data Review (EPA 2004), Region III Modifications for Organic Data Review (EPA 1994), and Region III Modifications for Inorganic Data Review (EPA 1993), as applicable. The samples were evaluated based on the following criteria:

- Data Completeness
- Technical Holding Times
- Initial/Continuing Calibrations
- Blanks
- Internal Standards
- Serial Dilutions
- Laboratory Control Samples
- Matrix Spike Recoveries
- Surrogate Recoveries
- Field Duplicates
- Identification/Quantitation
- Reporting Limits

Overall Evaluation of Data/Potential Usability Issues

Specific details regarding qualification of the data are addressed in the Specific Evaluation section of this narrative. If an issue is not addressed there were no actions required based on unmet quality criteria. When more than one qualifier is associated with a compound/analyte, the validator has chosen the qualifier that best indicates possible bias in the results and qualified these data accordingly.

Data Completeness

The SDG was received complete and intact. Resubmissions were not required.

Technical Holding Times

According to the chain of custody records, sampling was performed on 6/16/10-6/18/10. Samples were received at the laboratory on 6/19/10. All sample preparation analysis was performed within holding time requirements with the exception of sample EB01-061710RE. Qualified data are summarized in **Attachment 1**.

Blanks

Various detects were found in the calibration blanks, method blanks, and equipment blanks for all methods. Qualified data are summarized in **Attachment 1.**

Matrix Spike/Spike Duplicate

Various compounds in the methods exhibited either high or low recoveries in the MS/MSD.

Antimony exhibited recoveries well below the lower control limits. For sample OCMGBR-SB01-0610 recoveries were 11.7/10.4% for MS/MSD. For sample DNRR-SS08-0610 recoveries were 23.7/22.7% for MS/MSD. These samples were rejected due to recoveries below 30%.

Qualified data are summarized in **Attachment 1**.

Re-extractions

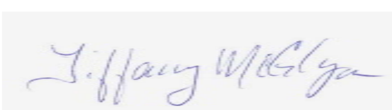
All qualified data are summarized in **Attachment 1** except for those excluded for re-extractions.

Conclusion

These data can be used in the project decision-making process as qualified by the data quality evaluation process.

Please do not hesitate to contact us about this validation report.

Sincerely,



Tiffany McGlynn

Qualification Flags

Exclude	More appropriate data exist for this analyte.
R	Data were rejected for use.
UL	Analyte not detected, quantitation limit is potentially biased low.
UJ	Analyte not detected, estimated quantitation limit.
U	Analyte not detected.
B	Not detected substantially above the level reported in laboratory or field blanks.
L	Analyte present, estimated value potentially biased low.
K	Analyte present, estimated value potentially biased high.
N	Analyte identification presumptive; no second column analysis performed or GC/MS tentative identification.
J	Analyte present, estimated value.
NJ	Analysis indicates the presence of an analyte that was "tentatively identified" and the associated value represents its approximate concentration.
None	Placeholder for calculating quality control issues that do not require flagging.
=	Analyte was detected at a concentration greater than the quantitation limit.

Qualifier Code Reference

Value	Description
%SOL	High Moisture content
2C	Second Column – Poor Dual Column Reproducibility
2S	Second Source – Bad reproducibility between tandem detectors
BD	Blank Spike/Blank Spike Duplicate(LCS/LCSD) Precision
BRL	Below Reporting Limit
BSH	Blank Spike/LCS – High Recovery
BSL	Blank Spike/LCS – Low Recovery
CC	Continuing Calibration
CCH	Continuing Calibration Verification – High Recovery
CCL	Continuing Calibration Verification – Low Recovery
DL	Redundant Result – due to Dilution
EBL	Equipment Blank Contamination
EMPC	Estimated Possible Maximum Concentration
ESH	Extraction Standard - High Recovery
ESL	Extraction Standard - Low Recovery
FBL	Field Blank Contamination
FD	Field Duplicate
HT	Holding Time
ICB	Initial Calibration – Bad Linearity or Curve Function
ICH	Initial Calibration – High Relative Response Factors
ICL	Initial Calibration – Low Relative Response Factors
ISH	Internal Standard – High Recovery
ISL	Internal Standard – Low Recovery
LD	Lab Duplicate Reproducibility
LR	Concentration Exceeds Linear Range
MBL	Method Blank Contamination
MDP	Matrix Spike/Matrix Spike Duplicate Precision
MI	Matrix interference obscuring the raw data
MSH	Matrix Spike and/or Matrix Spike Duplicate – High Recovery
MSL	Matrix Spike and/or Matrix Spike Duplicate – Low Recovery
OT	Other
PD	Pesticide Degradation

Value	Description
RE	Redundant Result - due to Reanalysis or Re-extraction
SD	Serial Dilution Reproducibility
SSH	Spiked Surrogate – High Recovery
SSL	Spiked Surrogate – Low Recovery
TBL	Trip Blank Contamination
TN	Tune

CTO-WE03
Attachment 1 Change Qual. Table
SDG 1006152

Sample ID	Compound	Q Flag	Qual Code
DNPRN-SS05-0610	Lead	B	CCBL
DNPRN-SS10-0610	Lead	B	CCBL
DNPRN-SS12-0610	Lead	B	CCBL
DNPRN-SS17-0610	Lead	B	CCBL
DNPRN-SS18-0610	Lead	B	CCBL
DNPRN-SS18P-0610	Lead	B	CCBL
DNPRN-SS16-0610	Lead	B	CCBL
DNPRN-SS16P-0610	Lead	B	CCBL
DNPRN-SS13-0610	Lead	B	CCBL
DNPRN-SS19-0610	Lead	B	CCBL
DNSTR-SS07-0610	Naphthalene	B	EBL
DNSTR-SS05-0610	Naphthalene	B	EBL
DNSTR-SS06-0610	Naphthalene	B	EBL
EB01-061710	2-Methylnaphthalene	UJ	HT
EB01-061710	Acenaphthene	UJ	HT
EB01-061710	Acenaphthylene	UJ	HT
EB01-061710	Anthracene	UJ	HT
EB01-061710	Benzo(a)anthracene	UJ	HT
EB01-061710	Benzo(a)pyrene	UJ	HT
EB01-061710	Benzo(b)fluoranthene	UJ	HT
EB01-061710	Benzo(g,h,i)perylene	UJ	HT
EB01-061710	Benzo(k)fluoranthene	UJ	HT
EB01-061710	Chrysene	UJ	HT
EB01-061710	Dibenz(a,h)anthracene	UJ	HT
EB01-061710	Fluoranthene	UJ	HT
EB01-061710	Fluorene	UJ	HT
EB01-061710	Indeno(1,2,3-cd)pyrene	UJ	HT
EB01-061710	Naphthalene	J	HT
EB01-061710	Phenanthrene	J	HT
EB01-061710	Pyrene	UJ	HT
DNPRN-SS12-0610	Zinc	B	MBL
DNPRN-SS17-0610	Zinc	B	MBL
DNPRN-SS18-0610	Zinc	B	MBL
DNPRN-SS18P-0610	Zinc	B	MBL
DNPRN-SS16-0610	Zinc	B	MBL
DNPRN-SS16P-0610	Zinc	B	MBL
DNPRN-SS11-0610	Zinc	B	MBL
DNPRN-SS11P-0610	Zinc	B	MBL
DNPRN-SS14-0610	Zinc	B	MBL
DNPRN-SS14P-0610	Zinc	B	MBL
DNPRN-SS13-0610	Zinc	B	MBL
DNPRN-SS19-0610	Zinc	B	MBL
DNPRN-SS20-0610	Zinc	B	MBL

DNRR-SS08-0610	Zinc	K	MSH
DNSTR-SS07-0610	Anthracene	L	MSL
DNSTR-SS07-0610	Benzo(a)anthracene	L	MSL
DNSTR-SS07-0610	Benzo(a)pyrene	L	MSL
DNSTR-SS07-0610	Benzo(b)fluoranthene	L	MSL
DNSTR-SS07-0610	Benzo(g,h,i)perylene	L	MSL
DNSTR-SS07-0610	Benzo(k)fluoranthene	L	MSL
DNSTR-SS07-0610	Chrysene	L	MSL
DNSTR-SS07-0610	Dibenz(a,h)anthracene	L	MSL
DNSTR-SS07-0610	Fluoranthene	L	MSL
DNSTR-SS07-0610	Phenanthrene	L	MSL
DNSTR-SS07-0610	Pyrene	L	MSL
DNSTR-SS05-0610	2-Methylnaphthalene	L	MSL
OFMGBR-SS08-0610	Antimony	L	MSL
OFMGBR-SS08-0610	Zinc	L	MSL
OCMGBR-SB01-0610	Antimony	R	MSL
OCMGBR-SB01-0610	Copper	L	MSL
DNRR-SS08-0610	Antimony	R	MSL

MEMORANDUM

Data Validation Summary

Oceana CTO-WE03-0511, Skeet and Trap Range

TO: Megan Morrison/WDC

Anita Dodson/WDC

FROM: Tiffany McGlynn/GNV

CC: Herb Kelly/GNV

DATE: July 5, 2011

Introduction

The following data validation report discusses the data validation process and findings for Empirical Laboratories, Inc. for SDG 1105097.

Samples were analyzed using the following analytical methods:

- SW-846 6010B Metals, Total
- SW-846 8270C Semivolatiles-PAH

The samples included in this SDG are listed in the table below.

Sample Name	Matrix
DNSTR-SD01-0511	Soil
DNSTR-SD01P-0511	Soil
DNSTR-SD02-0511	Soil
DNSTR-EB050911	Water
DNSTR-SD03-0511	Soil
DNSTR-SD07-0511	Soil
DNSTR-SD11-0511	Soil
DNSTR-SD12-0511	Soil
DNSTR-SD08-0511	Soil
DNSTR-SD04-0511	Soil

Sample Name	Matrix
DNSTR-SD05-0511	Soil
DNSTR-SD09-0511	Soil
DNSTR-SD13-0511	Soil
DNSTR-SD16-0511	Soil
DNSTR-SD17-0511	Soil
DNSTR-SD17P-0511	Soil
DNSTR-SD14-0511	Soil
DNSTR-SD20-0511	Soil
DNSTR-SD19-0511	Soil
DNSTR-SD15-0511	Soil
DNSTR-SD18-0511	Soil
DNSTR-SD10-0511	Soil
DNSTR-SD06-0511	Soil
DNSTR-EB051011	Water
DNSTR-FB051011	Water

Data Evaluation

Data was evaluated in accordance with the analytical methods and with the criteria found in the following guidance documents: National Functional Guidelines for Superfund Organic Methods Data Review (EPA 2008), National Functional Guidelines for Inorganic Methods Data Review (EPA 2010), Region III Modifications for Organic Data Review (EPA 1994) and Region III Modifications for Inorganic Data Review (EPA 1993) as applicable. The samples were evaluated based on the following criteria:

- Data Completeness
- Technical Holding Times
- Initial/Continuing Calibrations
- Blanks
- Internal Standards
- Serial Dilutions
- Laboratory Control Samples
- Matrix Spike Recoveries
- Surrogate Recoveries

- Field Duplicates
- Identification/Quantitation
- Reporting Limits

Overall Evaluation of Data/Potential Usability Issues

Specific details regarding qualification of the data are addressed in the sections below. If an issue is not addressed there were no actions required based on unmet quality criteria. When more than one qualifier is associated with a compound/analyte, the validator has chosen the qualifier that best indicates possible bias in the results and qualified these data accordingly.

Data Completeness

The SDG was received complete and intact.

Technical Holding Times

According to the chain of custody records, sampling was performed on 5/9/11 and 5/10/11. Samples were received at the laboratory on 5/11/11. All sample preparation and analyses were performed within holding time requirements with the exception of sample DNSTR-SD02-0511 for method 8270C PAH. Data were qualified and are summarized in **Attachment 1**.

Blanks

Naphthalene was detected in equipment blank and field blank in SDG 1105097. Sample results were well above the detection in the blanks therefore no data were qualified.

DNSTR-EB050911	Naphthalene	0.0602	ug/L
DNSTR-FB051011	Naphthalene	0.0687	ug/L

Matrix Spike/Spike Duplicate

Spiked sample DNSTR-SD02-0511 exhibited low recoveries in the MS/MSD for Lead. Affected data are summarized in **Attachment 1**.

Field Duplicate Precision

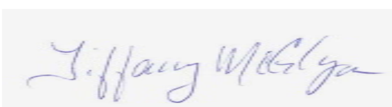
Sample DNSTR-SD01-0511 and field duplicate DNSTR-SD01P-0511 did not meet precision criteria for Fluoranthene and Pyrene. Affected data are summarized in **Attachment 1**.

Conclusion

These data can be used in the project decision-making process as qualified by the data quality evaluation process.

Please do not hesitate to contact us about this validation report.

Sincerely,



Tiffany McGlynn

Qualification Flags

Exclude	More appropriate data exist for this analyte.
R	Data were rejected for use.
UL	Analyte not detected, quantitation limit is potentially biased low.
UJ	Analyte not detected, estimated quantitation limit.
U	Analyte not detected.
B	Not detected substantially above the level reported in laboratory or field blanks.
L	Analyte present, estimated value potentially biased low.
K	Analyte present, estimated value potentially biased high.
N	Analyte identification presumptive; no second column analysis performed or GC/MS tentative identification.
J	Analyte present, estimated value.
NJ	Analysis indicates the presence of an analyte that was "tentatively identified" and the associated value represents its approximate concentration.
None	Placeholder for calculating quality control issues that do not require flagging.
=	Analyte was detected at a concentration greater than the quantitation limit.

Qualifier Code Reference

Value	Description
%SOL	High Moisture content
2C	Second Column – Poor Dual Column Reproducibility
2S	Second Source – Bad reproducibility between tandem detectors
BD	Blank Spike/Blank Spike Duplicate(LCS/LCSD) Precision
BRL	Below Reporting Limit
BSH	Blank Spike/LCS – High Recovery
BSL	Blank Spike/LCS – Low Recovery
CC	Continuing Calibration
CCBL	Continuing Calibration Blank Contamination
CCH	Continuing Calibration Verification – High Recovery
CCL	Continuing Calibration Verification – Low Recovery
DL	Redundant Result – due to Dilution
EBL	Equipment Blank Contamination
EMPC	Estimated Possible Maximum Concentration
ESH	Extraction Standard - High Recovery
ESL	Extraction Standard - Low Recovery
FBL	Field Blank Contamination
FD	Field Duplicate
HT	Holding Time
ICB	Initial Calibration – Bad Linearity or Curve Function
ICH	Initial Calibration – High Relative Response Factors
ICL	Initial Calibration – Low Relative Response Factors
IR15	Ion ratio exceeds +/- 15% difference
ISH	Internal Standard – High Recovery
ISL	Internal Standard – Low Recovery
LD	Lab Duplicate Reproducibility
LR	Concentration Exceeds Linear Range
MBL	Method Blank Contamination
MDP	Matrix Spike/Matrix Spike Duplicate Precision
MI	Matrix interference obscuring the raw data

Value	Description
MSH	Matrix Spike and/or Matrix Spike Duplicate – High Recovery
MSL	Matrix Spike and/or Matrix Spike Duplicate – Low Recovery
OT	Other
PD	Pesticide Degradation
RE	Redundant Result - due to Reanalysis or Re-extraction
SD	Serial Dilution Reproducibility
SSH	Spiked Surrogate – High Recovery
SSL	Spiked Surrogate – Low Recovery
TBL	Trip Blank Contamination
TN	Tune

Oceana CTO-WE03 0511, Skeet and Trap Range
Attachment 1 Change Qual. Table
SDG 1105097

Sample ID	Compound	Q Flag	Qual Code
DNSTR-SD01-0511	Fluoranthene	J	FD
DNSTR-SD01-0511	Pyrene	J	FD
DNSTR-SD01P-0511	Fluoranthene	UJ	FD
DNSTR-SD01P-0511	Pyrene	UJ	FD
DNSTR-SD02-0511	Lead	J	MSL
DNSTR-SD02-0511	2-Methylnaphthalene	UJ	HT
DNSTR-SD02-0511	Acenaphthene	UJ	HT
DNSTR-SD02-0511	Acenaphthylene	UJ	HT
DNSTR-SD02-0511	Anthracene	UJ	HT
DNSTR-SD02-0511	Benzo(a)anthracene	UJ	HT
DNSTR-SD02-0511	Benzo(a)pyrene	UJ	HT
DNSTR-SD02-0511	Benzo(b)fluoranthene	UJ	HT
DNSTR-SD02-0511	Benzo(g,h,i)perylene	UJ	HT
DNSTR-SD02-0511	Benzo(k)fluoranthene	UJ	HT
DNSTR-SD02-0511	Chrysene	UJ	HT
DNSTR-SD02-0511	Dibenz(a,h)anthracene	UJ	HT
DNSTR-SD02-0511	Fluoranthene	J	HT
DNSTR-SD02-0511	Fluorene	UJ	HT
DNSTR-SD02-0511	Indeno(1,2,3-cd)pyrene	UJ	HT
DNSTR-SD02-0511	Naphthalene	UJ	HT
DNSTR-SD02-0511	Phenanthrene	UJ	HT
DNSTR-SD02-0511	Pyrene	UJ	HT

Data Validation Summary

Oceana CTO-WE03-0511, Skeet and Trap Range

TO: Megan Morrison/WDC

Anita Dodson/WDC

FROM: Tiffany McGlynn/GNV

CC: Herb Kelly/GNV

DATE: July 5, 2011

Introduction

The following data validation report discusses the data validation process and findings for Empirical Laboratories, Inc. for SDG 1105116.

Samples were analyzed using the following analytical methods:

- SW-846 8270C Semivolatiles-PAH

The samples included in this SDG are listed in the table below.

Sample Name	Matrix
DNSTR-SS22-0511	Soil
DNSTR-SS22-0511	Soil
DNSTR-SS23-0511	Soil
DNSTR-SS24-0511	Soil
DNSTR-SS24-0511	Soil
DNSTR-SS25-0511	Soil
DNSTR-EB051111	Water

Data Evaluation

Data was evaluated in accordance with the analytical methods and with the criteria found in the following guidance documents: National Functional Guidelines for Superfund Organic Methods Data Review (EPA 2008) and Region III Modifications for Organic Data Review (EPA 1994) as applicable. The samples were evaluated based on the following criteria:

- Data Completeness
- Technical Holding Times
- Initial/Continuing Calibrations
- Blanks
- Internal Standards
- Serial Dilutions
- Laboratory Control Samples
- Matrix Spike Recoveries
- Surrogate Recoveries
- Field Duplicates
- Identification/Quantitation
- Reporting Limits

Overall Evaluation of Data/Potential Usability Issues

Specific details regarding qualification of the data are addressed in the sections below. If an issue is not addressed there were no actions required based on unmet quality criteria. When more than one qualifier is associated with a compound/analyte, the validator has chosen the qualifier that best indicates possible bias in the results and qualified these data accordingly.

Data Completeness

The SDG was received complete and intact.

Technical Holding Times

According to the chain of custody records, sampling was performed on 5/11/11. Samples were received at the laboratory on 5/12/11. All sample preparation and analyses were performed within holding time requirements.

Blanks

Naphthalene was detected in equipment blank and field blank in SDG 1105097. Sample results were well above the detection in the blanks therefore no data were qualified.

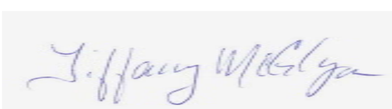
DNSTR-EB050911	Naphthalene	0.0602	ug/L
DNSTR-FB051011	Naphthalene	0.0687	ug/L

Conclusion

These data can be used in the project decision-making process as qualified by the data quality evaluation process.

Please do not hesitate to contact us about this validation report.

Sincerely,



Tiffany McGlynn

Qualification Flags

Exclude	More appropriate data exist for this analyte.
R	Data were rejected for use.
UL	Analyte not detected, quantitation limit is potentially biased low.
UJ	Analyte not detected, estimated quantitation limit.
U	Analyte not detected.
B	Not detected substantially above the level reported in laboratory or field blanks.
L	Analyte present, estimated value potentially biased low.
K	Analyte present, estimated value potentially biased high.
N	Analyte identification presumptive; no second column analysis performed or GC/MS tentative identification.
J	Analyte present, estimated value.
NJ	Analysis indicates the presence of an analyte that was "tentatively identified" and the associated value represents its approximate concentration.
None	Placeholder for calculating quality control issues that do not require flagging.
=	Analyte was detected at a concentration greater than the quantitation limit.

Qualifier Code Reference

Value	Description
%SOL	High Moisture content
2C	Second Column – Poor Dual Column Reproducibility
2S	Second Source – Bad reproducibility between tandem detectors
BD	Blank Spike/Blank Spike Duplicate(LCS/LCSD) Precision
BRL	Below Reporting Limit
BSH	Blank Spike/LCS – High Recovery
BSL	Blank Spike/LCS – Low Recovery
CC	Continuing Calibration
CCBL	Continuing Calibration Blank Contamination
CCH	Continuing Calibration Verification – High Recovery
CCL	Continuing Calibration Verification – Low Recovery
DL	Redundant Result – due to Dilution
EBL	Equipment Blank Contamination
EMPC	Estimated Possible Maximum Concentration
ESH	Extraction Standard - High Recovery
ESL	Extraction Standard - Low Recovery
FBL	Field Blank Contamination
FD	Field Duplicate
HT	Holding Time
ICB	Initial Calibration – Bad Linearity or Curve Function
ICH	Initial Calibration – High Relative Response Factors
ICL	Initial Calibration – Low Relative Response Factors
IR15	Ion ratio exceeds +/- 15% difference
ISH	Internal Standard – High Recovery
ISL	Internal Standard – Low Recovery
LD	Lab Duplicate Reproducibility
LR	Concentration Exceeds Linear Range
MBL	Method Blank Contamination
MDP	Matrix Spike/Matrix Spike Duplicate Precision
MI	Matrix interference obscuring the raw data

Value	Description
MSH	Matrix Spike and/or Matrix Spike Duplicate – High Recovery
MSL	Matrix Spike and/or Matrix Spike Duplicate – Low Recovery
OT	Other
PD	Pesticide Degradation
RE	Redundant Result - due to Reanalysis or Re-extraction
SD	Serial Dilution Reproducibility
SSH	Spiked Surrogate – High Recovery
SSL	Spiked Surrogate – Low Recovery
TBL	Trip Blank Contamination
TN	Tune

Appendix C
Data Quality Evaluation

Data Quality Evaluation

1 Data Quality Assessment

This data quality evaluation assesses the effect of the overall analytical process on the "availability" of the analytical data. "Availability" in this context refers to whether results can be used by the project team based on their analytical soundness. If a result is analytically sound, it is available for use for evaluating the potential releases, nature and extent of contamination, and estimating potentially associated human health and ecological risks. However, a particular result or group of results may not be "usable" for these purposes if other conditions apply. In order to avoid confusion of terms, this data quality evaluation differentiates the "availability" of results from "usability" of results. "Available" results are analytically sound and available for use by the project team to make decisions, even if they are not usable for a particular purpose.

The three major categories of data evaluation are laboratory performance, field collection performance (i.e. blank contamination and field duplicate reproducibility), and matrix interference. Evaluation of laboratory performance is a check for the laboratory's compliance with the method requirements. Additionally, a data validator conducts a review of the laboratory data to assess whether the analytical methods were within required control limits. Evaluation of field collection performance, such as blank contamination and field duplicates, involves the review of field quality control (QC) samples and the determination of their effect on the sample results. Evaluation of potential matrix interferences involved the review of several areas of results, including surrogate spike recoveries and duplicate sample results.

The data evaluation and validation is a multi-tiered approach. The process begins with an internal laboratory review, continues with an independent review by a data validator, and ends with an overall review by the CH2M HILL project chemistry team. While only the data validator is allowed to apply qualifiers to the data, the process provides a medium for essential communication between the laboratory, validator, and project team, and allows for data quality to be thoroughly evaluated.

1.1 Laboratory Internal Quality Control Review

Prior to releasing the analytical data, the laboratory reviewed both the sample and QC data to verify sample identity, instrument calibration, quantitation limits, dilution factors, numerical computations, accuracy of transcriptions, and chemical interpretations. To define a laboratory QC exceedance and the appropriate corrective action, the laboratory referred to its in-house SOPs and the limits agreed to in the Naval Air Station (NAS) Oceana *Sampling and Analysis Plan for the Site Inspection of Former Small Arms Firing Ranges* (CH2M HILL, 2010). The SOPs were based on Department of Defense requirements, the analytical method, and accumulated laboratory experience. If a laboratory QC exceedance occurred, the situation was reviewed by the appropriate personnel to determine whether it was acceptable or it would require corrective action by the laboratory.

In addition, the QC data were tabulated and the results reviewed to determine whether they were within the contract-required limits for accuracy and precision. Any non-conforming data was discussed in the data package cover letter and case narrative.

1.2 Data Validation

An internal data validator reviewed all data packages using the validation criteria outlined in the Site Investigation Report (CH2M HILL, 2010). Analytical methods and laboratory standard operating procedures (SOPs) presented in the sampling and analysis plan (SAP) were used to evaluate compliance against quality assurance (QA)/QC criteria. If QA/QC criteria were not met, data was considered for qualification. The data qualifiers were those presented in *Region III Modifications to the National Functional Guidelines for Organic Data Review (September 1994)* and *Region III Modifications to National Functional Guidelines for Inorganic Data Review (April 1993)*. These guidelines were not used for data validation; however, the specific qualifiers listed therein may have been applied to data had non-conformances against the QA/QC criteria been identified.

The data validation process was focused on the effects of the laboratory's performance and the sample matrices' effects on the analytical results. Areas of review consisted of holding time compliance, surrogate recovery accuracy, blank contamination (field, trip, equipment, and method blanks), initial and continuing calibration accuracy and precision, laboratory control sample (LCS) accuracy, internal standard response and retention time accuracy, instrument tune criteria accuracy, matrix spike and matrix spike duplicate (MS/MSD) recovery and duplicate sample precision (laboratory and field duplicates). Additionally, the analytical spectrum and raw data output were reviewed and 10% of the laboratory results were recalculated from the raw data to verify final laboratory identification and quantitation.

When multiple analyses were performed, the analytical run with the lowest quantitation limits was selected by the validator if the QC criteria were met for that analysis. If a sample was analyzed more than once as a result of concentrations exceeding the calibration range, the data validator selected results from the appropriate dilution.

1.3 General Data Qualifiers and Usability

In general, the data validator examines each data point and determines any effects that QC exceedances may have had.

The J-qualification and U-qualification of results are common occurrences and have no adverse effect on the availability of that result to the project team for making decisions. J-qualified results are available, at the reported result, for use as detects as long as they are considered "estimated" by the project team. Human health risk assessment guidance suggests that these qualifiers "indicate uncertainty in the reported concentration of the chemical, but not in its assigned identity. Therefore, these data can be used just as positive data with no qualifiers or codes." In addition, one should use "J-qualified concentrations the same way as positive data that do not have this qualifier" (<u>Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual</u>. (Part A) EPA/540/1-89/002. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 1989). U-qualified results are available, at the reported quantitation limit, for use as non-detects as long as they are considered "non-detect" as appropriate.

The B-qualification indicates that the results may be attributable to field or laboratory blank contamination, and that the analyte was detected in the associated blank as well as in the sample. B-qualified results are usable as non-detects as long as they are considered "not detected at significantly greater concentration than that in an associated blank."

The K-qualification and L-qualification indicate the data is affected by an undeterminable degree of positive or negative bias. This may indicate the presence of a QC problem, but not a problem severe enough to warrant rejection of data. K-qualified results are usable as detects as long as they are considered "estimated and biased high." L-qualified results are available for use as detects as long as they are considered "estimated and biased low."

In certain cases, a result is R-qualified and deemed to be unreliable and unusable. "Unusable" in this instance is defined as a result that is not analytically sound and is not considered available for use by the project team. In some cases, the project team may still decide to use an R-qualified result. An example of this occurrence would be if a result is R-qualified because it is biased extremely high, yet it is still below the project action limits. A conservative decision may be made to consider this result a non-exceedance, even if its concentration was deemed unreliable. For that reason, it is important to examine why a result was R-qualified. For the most part, however, R-qualified results are not usable, and it is the only qualifier that has an adverse effect on the availability of data. There are R-qualified data points in this data set.

1.4 Project-Specific Data Qualifiers and Usability

The following sections examine the data validation qualifiers used on surface soil and subsurface soil sample data from six sites that comprise the NAS Oceana Small Arms Firing Range.

1.4.1 Primary Data Validation Qualifiers

The following data validation qualifiers were applied to one or more analytical results:

- **U** - Not detected. Sample was analyzed for this parameter, but it was not detected at a concentration greater than the reported quantitation limit.
- **J** - Concentration estimated. The parameter was positively identified and the associated numerical value is the approximate concentration of the parameter in the sample.
- **B** – Not detected substantially above the level reported in laboratory or field blanks.
- **L** – Analyte present. Reported value may be biased low. Actual value is expected to be higher.
- **K** – Analyte present. Reported value may be biased high. Actual value is expected to be lower.
- **R** – Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
- **[No qualifier present] or "NULL" -** Detected. Qualification was not warranted.

1.4.2 Secondary Data Validation Qualifiers

The following secondary data validation qualifiers were applied to one or more analytical results resulting in the following combinations:

Validator Qualifier	Secondary Qualifier Code	Count	Percent	Available as Reported	Available as Qualified	Not Available	Impact on PARCC[1]	Explanation
NULL	NULL	478	73.54%	X				Constituent was analyzed for and detected. Further qualification was not necessary (no QA/QC exceedances). The result is usable as a detect as reported.
U	NULL	72	11.08%	X				Constituent was analyzed for but not detected. Further qualification was not necessary. The result is usable as a nondetect at the reported quantitation limit.
J	BRL	46	7.08%	X				Constituent was analyzed for and detected. The detection was less than the quantitation limit and J-qualified (as in "below reporting limit") by the laboratory. Further qualification was not necessary (no QA/QC exceedances) except to standardize the qualifier to a valid value. The result is usable as a detect as reported.
B	MBL	17	2.62%		X			Constituent was analyzed for and detected. The result was B-qualified as "not detected substantially above the level reported in laboratory blanks" due to method blank contamination. The result is usable as a nondetect as qualified.
L	MSL	16	2.46%		X			Constituent was analyzed for and detected. The result was L-qualified as "biased low" due to low recovery in a matrix spike and/or matrix spike duplicate. The QA/QC exceedance (potential low bias) was not severe enough to warrant rejection. The result is usable as a detect as qualified.
B	CCBL	10	1.54%		X			Constituent was analyzed for and detected. The result was B-qualified as "not detected substantially above the level reported in laboratory blanks" due to continuing calibration blank contamination. The result is usable as a nondetect as qualified.

Validator Qualifier	Secondary Qualifier Code	Count	Percent	Available as Reported	Available as Qualified	Not Available	Impact on PARCC[1]	Explanation
B	EBL	8	1.23%		X			Constituent was analyzed for and detected. The result was B-qualified as "not detected substantially above the level reported in field blanks" due to equipment blank contamination. The result is usable as a nondetect as qualified.
R	MSL	2	0.31%			X	A, C	Constituent was analyzed for and may or may not have been detected. The result was R-qualified as "unreliable" due to recovery exceeding the lower limit in a matrix spike and/or matrix spike duplicate (MS/MSD). This is indicative of matrix effects or matrix interference and laboratory performance is often assured by acceptable laboratory control sample recoveries. The QA/QC exceedance (extreme low bias) was severe enough that the result should not be used as a detect or as a nondetect for any purpose. This has a negative impact on completeness and a negative impact on accuracy.
K	MSH	1	0.15%		X			Constituent was analyzed for and detected. The result was K-qualified as "biased high" due to high recovery in a matrix spike and/or matrix spike duplicate. The QA/QC exceedance (potential high bias) was not severe enough to warrant rejection. The result is usable as a detect as qualified.
TOTALS:		**650**	**100.00%**	**91.69%**	**8.00%**	**0.31%**		
				99.69% Data Completeness				

[1] PARCC is "Precision, Accuracy, Representativeness, Completeness and Comparability". See Section 1.4.3 for more details.

1.4.3 Impacts on Precision, Accuracy, Representativeness, Completeness, Comparability (PARCC)

1.4.3.1 Precision

Precision is defined as the agreement between duplicate results, and was characterized by comparing MS/MSD relative percent differences (RPDs), serial dilutions, laboratory replicates, and field duplicate sample results. Although results may have been qualified due to QC exceedances that may suggest an impact on precision, there is no actual significant negative impact on precision unless a data point is deemed unreliable due to precision exceedances.

1.4.3.2 Accuracy/Bias

Accuracy/bias is a measure of the agreement between an analytical determination and the true value of the parameter being measured. For organic analyses, each sample was spiked with surrogate compounds; and for organic and inorganic analyses, an MS/MSD and LCS were spiked with a known parameter concentration before preparation. Internal standards, surrogates and MS/MSDs provide a measure of the matrix effects on the analytical accuracy. The LCS demonstrates accuracy of the method and the laboratory's ability to meet the method criteria. Accuracy/bias is also assessed by calibration recoveries. Although results may have been qualified due to QC exceedances that may suggest an impact on accuracy/bias, there is no actual significant negative impact on accuracy unless a data point is deemed unusable (rejected) due to accuracy exceedances. R-qualification of results may have a negative impact on accuracy/bias due to low percent MS and/or MSD recoveries.

1.4.3.3 Representativeness

Representativeness is a qualitative measure of the degree to which sample data accurately and precisely represent a characteristic environmental condition (in this case, the nature and extent of contamination). Representativeness is a subjective parameter and is used to evaluate the efficacy of the sample planning design. In terms of data quality, representativeness was assured because the sampling team followed approved standard operating procedures (SOPs) for sample collection and handling, and the laboratory followed approved SOPs for sample handling, preparation, and analysis.

1.4.3.4 Completeness

Completeness will be calculated as the number of analytically-sound results that are available for use compared to the total number of measurements made. All results except those R-qualified as "unreliable" are available for use as analytically-sound results. The R-qualifier is the only qualifier that negatively affects a data point's availability. A completeness goal was not specified in the UFP-SAP; therefore, a general 95% completeness goal was applied. Overall, the entire data set was 99.69% complete and the goal was met.

1.4.3.5 Comparability

Comparability is a qualitative measure designed to express the confidence with which one data set may be compared to another. Factors that affect comparability are sample collection and handling techniques, sample matrix, and analytical methods. In this case, because approved SOPs were used for sample collection and handling, common sample matrices were evaluated (surface and subsurface soil), and EPA methods were utilized, the data user may express confidence in the fact that this data set is comparable to others of acceptable data quality. In addition, comparability is controlled by the other PARCC parameters because data sets can be compared with confidence only when precision and accuracy are known. Except in the case of rejected data, precision and accuracy were demonstrated to be acceptable, and the data user may be confident that this data set is comparable to others of high data quality.

2 Data Quality Evaluation

The purpose of this data quality evaluation is to summarize the findings of the data validation and any effects it found concerning the availability of the data for the site investigation at various NAS Oceana sites.

2.1 Fleet Combat Training Center Dam Neck Annex – Pistol Range North

This section evaluates the analytical results of the surface soil samples at the Fleet Combat Training Center Dam Neck Annex, Pistol Range (North) collected on June 16th, 2010.

2.1.1 Select Metals Data

Select metals were analyzed by SW-846 method 6010B. Excluding field quality control samples, 132 distinct data points were generated. The select metals data set is 100% complete and available for use. The validation process issued the following qualifiers for results in the select metals fraction:

Validator Qualifier	Secondary Qualifier Code	Count	Percent	Available as Reported	Available as Qualified
NULL	NULL	62	46.97%	X	
U	NULL	25	18.94%	X	
J	BRL	22	16.67%	X	
B	MBL	13	9.85%		X
B	CCBL	10	7.58%		X
TOTALS:		**132**	**100.00%**	**82.58%**	**17.42%**

See the table in section 1.4.2 for an explanation of qualifications and their impact on data usability.

2.2 Fleet Combat Training Center Dam Neck Annex – Pistol Range South

This section evaluates the analytical results of the surface soil samples at the Fleet Combat Training Center Dam Neck Annex, Pistol Range (North) collected on April 14th, 2010.

2.2.1 Select Metals Data

Select metals were analyzed by SW-846 method 6010B. Excluding field quality control samples, eighteen distinct data points were generated. The select metals data set is 100% complete; all results are available for use as reported. The validation process issued the following qualifiers for results in the select metals fraction:

Validator Qualifier	Secondary Qualifier Code	Count	Percent	Available as Reported
NULL	NULL	15	83.33%	X
U	NULL	3	16.67%	X
TOTALS:		**18**		**100.00%**

See the table in section 1.4.2 for an explanation of qualifications and their impact on data usability.

2.3 Fleet Combat Training Center Dam Neck Annex – Rifle Range

This section evaluates the analytical results of the surface soil samples at the Fleet Combat Training Center Dam Neck Annex, Rifle Range collected on April 15th -16th, 2010.

2.3.1 Select Metals Data

Select metals were analyzed by SW-846 method 6010B. Excluding field quality control samples, 168 distinct data points were generated. The select metals data set is 99.40% complete, which meets the overall completeness goal of 95%; all results that aren't R-qualified are available for use as reported or as qualified. 0.60% of the results are unreliable and not available for use by the project team. The validation process issued the following qualifiers for results in the select metals fraction:

Validator Qualifier	Secondary Qualifier Code	Count	Percent	Available as Reported	Available as Qualified	Not Available	Impact on PARCC[1]
NULL	NULL	128	76.19%	X			
U	NULL	27	16.07%	X			
B	EBL	5	2.98%		X		
B	MBL	4	2.38%		X		
J	BRL	1	0.60%	X			
L	MSL	1	0.60%		X		
K	MSH	1	0.60%		X		
R	MSL	1	0.60%			X	A, C
TOTALS:		**168**	**100.00%**	**92.86%**	**6.55%**	**0.60%**	
					Completeness = 99.40%		

Please see the table in section 1.4.2 for an explanation of qualifications and their impact on data usability.

The result for Antimony in sample DNRR-SS08-0610 was rejected due to low recovery of Antimony in both the MS and MSD performed on this sample. This is indicative of a potential extremely low bias for Antimony in this sample. Therefore, this result is unreliable and not available for use.

2.4 Fleet Combat Training Center Dam Neck Annex – Skeet and Trap Range

This section evaluates the analytical results of the surface soil samples at the Fleet Combat Training Center Dam Neck Annex, Skeet and Trap Range collected on April 17th, 2010.

2.4.1 Select Metals (Lead) Data

Select metals (lead only) were analyzed by SW-846 method 6010B. Excluding field quality control samples, 21 distinct data points were generated. The select metals data set is 100% complete, which meets the overall completeness goal of 95%; all results are available for use as reported. The validation process issued the following qualifiers for results in the select metals fraction:

Validator Qualifier	Secondary Qualifier Code	Count	Percent	Available as Reported
NULL	NULL	21	100.00%	X
TOTALS:		**21**	**100.00%**	**100%**

Please see the table in section 1.4.2 for an explanation of qualifications and their impact on data usability.

2.4.2 Polycyclic Aromatic Hydrocarbons Data

Polycyclic Aromatic Hydrocarbons (PAHs) were analyzed by SW-846 method 8270C Selected Ion Monitoring (SIM). Excluding field quality control samples, 119 distinct data points were generated. The PAHs data set is 100% complete, which meets the overall completeness goal of 95%; all results are available for use as reported. The validation process issued the following qualifiers for results in the select metals fraction:

Validator Qualifier	Secondary Qualifier Code	Count	Percent	Available as Reported	Available as Qualified
NULL	NULL	77	64.71%	X	
J	BRL	16	13.45%	X	
L	MSL	12	10.08%		X
U	NULL	11	9.24%	X	
B	EBL	3	2.52%		X
TOTALS:		**119**	**100.00%**	**87.39%**	**12.61%**

Please see the table in section 1.4.2 for an explanation of qualifications and their impact on data usability.

2.5 NAS Oceana - Machine Gun Boresight Range

This section evaluates the analytical results of the surface and subsurface soil samples at the NAS Oceana Machine Gun Boresight Range collected on April 18th, 2010.

2.5.1 Select Metals Data

Select metals were analyzed by SW-846 method 6010B. Excluding field quality control samples, 96 distinct data points were generated. The select metals data set is 98.96% complete, which meets the overall completeness goal of 95%; all results that aren't R-qualified are available for use as reported or as qualified. 1.04% of the results are unreliable and not available for use by the project team. The validation process issued the following qualifiers for results in the select metals fraction:

Validator Qualifier	Secondary Qualifier Code	Count	Percent	Available as Reported	Available as Qualified	Not Available	Impact on PARCC[1]
NULL	NULL	87	90.63%	X			
J	BRL	4	4.17%	X			
U	NULL	3	3.13%	X			
R	MSL	1	1.04%			X	
L	MSL	1	1.04%		X		A, C
TOTALS:		**96**	**100.00%**	**97.92%**	**1.04%**	**1.04%**	
				Completeness = 98.96%			

Please see the table in section 1.4.2 for an explanation of qualifications and their impact on data usability.

The result for Antimony in sample OCMGBR-SB01-0610 was rejected due to low recovery of Antimony in both the MS and MSD performed on this sample. This is indicative of a potential extremely low bias for Antimony in this sample. Therefore, this result is unreliable and not available for use.

2.6 Naval Auxiliary Landing Field Fentress – Machine Gun Boresight Range

This section evaluates the analytical results of the surface and subsurface soil samples at the Naval Auxiliary Landing Field (NALF) Fentress – Machine Gun Boresight Range collected on April 18th, 2010.

2.6.1 Select Metals Data

Select metals were analyzed by SW-846 method 6010B. Excluding field quality control samples, 96 distinct data points were generated. The select metals data set is 100% complete; all results are available for use as reported and qualified. The validation process issued the following qualifiers for results in the select metals fraction:

Validator Qualifier	Secondary Qualifier Code	Count	Percent	Available as Reported	Available as Qualified
NULL	NULL	88	91.67%	X	
U	NULL	3	3.13%	X	
J	BRL	3	3.13%	X	
L	MSL	2	2.08%		X
TOTALS:		**96**	**100.00%**	**97.92%**	**2.08%**

See the table in section 1.4.2 for an explanation of qualifications and their impact on data usability.

3 Overall Assessment

The quality of the data reported for the surface and subsurface soil sampling at NAS Oceana in April 2010 is of excellent quality. A large majority (99.69%) of the data in this data set is available for use either as reported or qualified, and only 2 of 650 of results (0.31%) were rejected due to QA/QC issues during validation.